

# **THE JOURNAL OF RAPTOR RESEARCH**



VOLUME 21

SPRING 1987

NUMBER 1

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*The Journal of Raptor Research* (ISSN 0892-1016) is published quarterly for \$15.00 per year by The Raptor Research Foundation, Inc., 12805 St. Croix Trail, Hastings, Minnesota 55033, U.S.A. Application to mail at second class rate is pending at Hastings, Minnesota, and additional mailing office. Printed by Allen Press, Inc., Lawrence, Kansas, U.S.A.

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A QUARTERLY PUBLICATION OF THE RAPTOR RESEARCH FOUNDATION, INC.

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VOL. 21

SPRING 1987

No. 1

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*J. Raptor Res.* 21(1):1

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## COMMENTARY

### Year-End Message From the President, January 1987

**NEW DIRECTOR AND OFFICERS.** The ballots for directors are in and the results are as follows: Mike Collopy (At Large #1); Dave Bird (Canadian, East); and Grainger Hunt (Pacific and Mountain). Grainger is a new Board member and we welcome him aboard.

As I reported at last year's Business Meeting, 1987 will be my last year as President. Three, two-year terms are long enough for both the organization and the individual. I am delighted to announce that your Board of Directors has asked Gary Duke to be your next President; his term begins January 1988. I am equally pleased that they asked Richard Clark to "re-up" for a second term as Vice-President. Our organization is in good hands and I wish both Gary and Dick the best of luck as we enter a new passage in the life of the Foundation.

**1986—A YEAR OF MANY FIRSTS.** Not only did our membership surpass 1,000 in 1986, for the first time, but we were able to award two grants: \$500 from The Leslie Brown Memorial Fund and \$500 from the Steven Tully Memorial Fund. By a unique coincidence both award committees chose Vicky Meretsky for her application to work on the Egyptian Vulture in Israel. Our membership directory, "The Kettle," has undergone its first update and includes a "Raptor Organization Directory." Both products are thanks to the efforts of Dick Clark. Members will receive their updated directory in 1987.

**THE ANNUAL MEETING.** Our annual meeting is usually the highlight of the Foundation's efforts each year, and thanks to Mike Collopy and his Local Committee, 1986 was no exception. Over one hundred authors contributed to a total of over seventy scientific papers. A special thanks also goes to Keith Bildstein, 1986 Program Chairman, for providing such a rich array of presentations. The winner of the Anderson Award for the Best Student Paper at the Annual Meeting was John A. Smallwood (Ohio State University), for his paper, entitled "Winter Territoriality in American Kestrels: A Mechanism of Sexual Segregation by Habitat." Congratulations to John! Dr. Lovett Williams, an honest-to-goodness Florida "Cracker" and Wildlife Biologist par excellence, was our entertaining and informative banquet speaker, which put the "icing on the cake."

Our 1987 meeting will be in Boise, Idaho, 28–31 October. Richard Howard, Chairman of the Local Committee, can be reached at: U.S. Fish & Wildlife Service, 4696 Overland Road, Room 576, Boise, Idaho 83705; (208) 334-1888 (FTS 554-1888). Two workshops will be held in conjunction with the conference: NWF's "Western Raptor Management" and the Peregrine Fund's "Captive Raptor Propagation Techniques," both 26–28 October. Questions concerning the program should be addressed to the Program Chairperson, Karen Steenhof, Boise District, BLM, 3948 Development Avenue, Boise, Idaho 83705; (208) 334-9277 (FTS 544-9277). Current members will automatically receive announcements and details, so make sure your membership and address are up-to-date. See you there!

**A NEW EDITOR, A NEW PRESS.** Clayton White has served as Editor of *Raptor Research* for 10 years and has done an outstanding job of shepherding our journal through troublesome, adolescent stages. Clayton is taking a well-deserved break but before stepping down as Editor, he initiated an exciting move to Allen Press, Inc. Our sincere thanks to Clayton for so many years of dedication and for the increased professional image that will come with the new press. Jimmie Parrish, who served as Clayton's Assistant Editor for many years, will be our new Editor, and I can't think of a better man for the job! Look for some big changes in our journal.

**AS A WRAP UP.** The past year was an impressive one but, with your input, 1987 can be even better. You, the Members, are what makes the Raptor Research Foundation what it is, and we welcome new members from all disciplines and areas of interest. For information on membership and publications or just to let me know what you're up to, please drop me a line. Have a great year.—Jeffrey L. Lincer, President.



## COMMENTARY

### *The Journal of Raptor Research: A NEW BEGINNING*

The end of 1986 marked the end of the first twenty years of The Raptor Research Foundation, Inc. The beginning of 1987 launches the Foundation into the next twenty years and beyond. Since incorporation in 1966, the Foundation has grown from a charter membership of six to a current membership of more than one thousand, and the scope has become international.

The Foundation's first publication was a quarterly newsletter entitled *Raptor Research News*. The *News* became *Raptor Research* and evolved into a peer reviewed, quarterly publication in 1971. With this the first issue of 1987, the journal begins a new chapter in its history. The journal has a new title, a new Editor, a new format, and a new publisher. I am very honored and also very happy to have been chosen Editor. As an Assistant Editor, I have learned a great deal about scientific literature and its uniqueness. The new title, *The Journal of Raptor Research*, and the new format reflect the uniqueness of our journal among the annals of scientific literature. The new publisher, Allen Press, Inc., reflects the continued commitment of the Foundation to fostering professionalism and expansion of the journal and other publications. Another distinction of the journal has been its welcome of manuscripts from novice raptor enthusiasts as well as amateur and professional scientists. Each has something of value to offer raptor ecology, whether it is a fresh approach or the culmination of years of study.

A journal represents the standard upon which a professional society is judged. A growing journal is evidence of a growing organization, and the Foundation and the journal have continued to grow and improve. I am committed to increasing the quality of manuscripts printed and to keeping the journal distributed on a quarterly schedule. Average manuscript rejection rate is now 32%, and the number of manuscripts received for publication has steadily increased. The battery of reviewers for submitted manuscripts has also increased, as evidenced in the list appearing in this issue. The list will continue to increase in order to better evaluate the diverse subjects of manuscripts being received for publication. Finally, the journal is now distributed to thirty-one countries outside the United States, including numerous libraries and literary institutions.

The Foundation's publications have made great strides over the years in becoming established among professional ornithological literature. I hope that each member will continue to support The Raptor Research Foundation, Inc., and publish in *The Journal of Raptor Research*. Your manuscripts will receive expeditious, quality reviews and professional editorial advice.—**Jimmie R. Parrish, Editor.**

## PREY SELECTION OF COMMON BARN-OWLS ON ISLANDS AND MAINLAND SITES

DAVID W. JOHNSTON AND JAMES M. HILL

**ABSTRACT.**—Data from the literature and a recent collection of Common Barn-Owl (*Tyto alba*) pellets from Block Island, Rhode Island, were used to assess the relative numbers of birds and non-avian vertebrates taken by this owl on islands and mainland sites. Our analysis supports the hypothesis that barn-owl diets include proportionately more birds (both species and individuals) on islands than at mainland sites. The percent of bird species and individual birds in the diet decreases from the equator to 54°N. Possible causes for island vs. mainland diets and latitudinal trends are discussed.

The interaction between the Common Barn-Owl (*Tyto alba*) and its prey is well documented. Published studies deal with economic aspects (Bendire 1895; Errington 1932; Wallace 1950), population ecology (Davis 1959; Otteni et al. 1972; Herrera and Jaksic 1980), and range extensions of mammalian prey (Kirkpatrick and Conway 1947; Stickel and Stickel 1948; Baker 1953; Parmalee 1954). This owl is believed to specialize on mammalian prey, but Johnston (1974: 172) reported a high percentage of bird species in barn-owl pellets from Grand Cayman Island, BWI. From that study and two other island reports available then, he proposed that "on some islands . . . where small mammalian prey is reduced in diversity and total numbers, the barn-owl becomes alternatively a significant predator of birds and other non-mammalian vertebrates." We now test that hypothesis by using data from additional published accounts of barn-owl diets on islands and mainland sites. While examining the data from those locations, we developed an additional hypothesis that barn-owl prey on more northerly islands includes fewer birds than on islands closer to the equator.

### MATERIALS AND METHODS

A search of the literature from the northern hemisphere yielded quantitative pellet analyses from 23 island sites occurring from the Galapagos Islands (0°) to Sheppey Isle (British Isles, 54°N) and from 50 mainland sites, mostly in the United States, but also from some localities in Spain, Poland, and Italy. Unpublished data from several islands in the British Isles were obtained from David E. Glue, as were unpublished data from Martha's Vineyard, Massachusetts (G. Jones and K. Driscoll). In Appendix I are unpublished data from Block Island, Rhode Island. Data extracted from these accounts are used in our statistical analyses (Mann-Whitney U-Test) and in the regression analyses.

To test the hypothesis suggested by Johnston (1974) that barn-owls take proportionately more birds on islands than on the mainland, pellet data from the literature were examined and compared in two ways: 1) by considering

the percent of *bird species* among all the vertebrate species captured, and 2) by considering the percent of all *individual birds* vs. individuals of all non-avian vertebrate prey.

### RESULTS AND DISCUSSION

**Prey Selection on Islands.** Most previous dietary studies of barn-owls from mainland sites have shown a preponderance of mammalian prey. Mammal prey species from the 50 mainland sites examined here constituted a mean of 92.4% (SD = 8.29) of the total vertebrate diet. Despite this preponderance of small mammal prey species, the mainland barn-owls took some small birds and, even less frequently, reptiles, amphibians, and insects. By contrast, on 23 island sites mammal species constituted a mean of only 60.5% (SD = 25.47).

The number of bird species as a percent of the total vertebrate prey species from islands ( $\bar{X}$  = 38.6) is significantly greater than values from mainland sites ( $\bar{X}$  = 19.9) (Table 1). Although the *number* of bird species *per se* does not differ significantly between islands and the mainland (Table 1), barn-owls took fewer mammal species on islands than on the mainland, thus making the proportion of bird species taken on islands higher. We also examined published data on the total number of individual birds and non-avian vertebrates extracted from pellets. The number of individual birds identified as a percent of all vertebrates is greater on islands ( $\bar{X}$  = 10.5) than on the mainland ( $\bar{X}$  = 4.0). Thus, barn-owls on islands prey proportionately more on birds than other vertebrates (mainly mammals), than at mainland sites.

Some published accounts are of interest because of the extremes (0–100%) of avian prey taken by barn-owls. For example, mainland areas from which no birds were reported include California (Foster 1927: 6 of 11 sites; Hawbecker 1945; Fitch 1947), Massachusetts (Boyd and Shriner 1954), South Carolina (Tedards 1963: one of four seasonal samples),

Table 1. A comparison of vertebrate prey of Common Barn-Owls between mainland and island sites.

PREY	MAINLAND <sup>a</sup>	ISLANDS <sup>b</sup>
All vertebrate species	$\bar{X}$ = 10.7; SD = 4.84 (U = 743; $P$ = 0.30)	$\bar{X}$ = 8.6; SD = 5.40
All bird species	$\bar{X}$ = 2.6; SD = 2.57 (U = 482; $P$ = 0.318)	$\bar{X}$ = 3.9; SD = 4.39
All mammal species	$\bar{X}$ = 8.0; SD = 3.26 (U = 941; $P$ < 0.0005)	$\bar{X}$ = 4.4; SD = 1.82
Number of bird species as percent of all vertebrate species	$\bar{X}$ = 19.9; SD = 16.52 (U = 312; $P$ < 0.01)	$\bar{X}$ = 38.6; SD = 24.63
Number of individual birds as percent of all vertebrate individuals	$\bar{X}$ = 4.0; SD = 6.51 (U = 284; $P$ = 0.008)	$\bar{X}$ = 10.5; SD = 14.34

<sup>a</sup> Data from 50 sites: references 1, 2, 7, 10, 14, 16, 17, 18, 20, 22, 23, 25, 26, 27, 28, 29, 30, 33, 36, 37, 38, 39, 41, 42, 43, 44, 46, 47, 49, 50, 51, 52, 53, 54, 55; D. Glue (unpubl. data).  
<sup>b</sup> Data from 23 sites: references 4, 5, 8, 11, 12, 13, 15, 21, 34, 56; D. Glue (unpubl. data); G. Jones and K. Driscoll (unpubl. data), Appendix I.

and Ireland (Fairley 1966: two of 10 seasonal samples). Island studies reporting no birds were those from Skomer (Brown and Twigg 1971), Bute (D. E. Glue, pers. comm.), and Martha's Vineyard (Choate 1972). At the other extreme, on some islands where extensive colonies of seabirds occur, barn-owls fed exclusively on birds (Bonnot 1928). The "outlier" or anomalous points in Figure 1 (60 units at 25°N) and Figure 2 (51 units at 25°N) came from the small and perhaps inadequate sample of Banks (1963) wherein the "remains of at least six Craveri Murrelets [*Brachyramphus craveri*] and at least four wood rats . . . , were identified."

**Latitudinal Variation.** We searched for relationships between latitude and bird prey in barn-owl diets using covariance analysis of the transformed percentages of vertebrate prey species that were birds (Fig. 1). ANCOVA indicated that a simple linear model is an adequate description for both the island and mainland data ( $P > 0.05$ ). The slopes of the regression lines were significantly different from zero ( $P = 0.05$ ), but there was no evidence that the two slopes were different from each other even though the y-axis intercepts were significantly different ( $P < 0.05$ ). Considering numbers of species found in pellets, effects of latitude were, therefore, the same on islands and the mainland. Toward the equator bird species comprised a significantly greater percentage of vertebrate prey species than at higher northern latitudes, although no comparable data were available for mainland sites from 0°–25°N. The best estimate of a common slope (islands and mainland) was that bird species in barn-owl diets decrease by approximately 6.2% for each 10° latitude northward.

By examining only mainland data for barn-owls in Europe, Herrera (1974) proposed a latitudinal effect and used a modification of the now-questionable (Pielou 1977) Shannon-Wiener diversity index, namely "trophic diversity in relation to biomass" of prey captured. Herrera's report, although not strictly comparable to the present study which focuses on avian prey selection, noted a significant negative correlation between trophic diversity in relation to biomass and north latitude.

Although the effects of latitude were the same for islands and mainland sites, the greater percentages of bird species taken on islands compared with mainland sites at the same latitude merit comment. We believe that this difference is due, at least in part, to the different relative numbers of available prey species, especially birds vs. small mammals. Such comparisons are often impossible to document and quantify because of the lack of published information on numbers of available species. On Grand Cayman at 19°N where barn-owl diets included about 60% bird species, only 5 small mammal species including 3 bats occur, whereas about 70 passerine bird species have been identified (Johnston 1974 and pers. obs.)

Regression lines for percentages of individual birds in the prey items also show a negative correlation with latitude but the y-intercepts are not significantly different from each other (Fig. 2). The best estimate for a common slope is a decrease in individual birds of approximately 7.3% for each 10° latitude northward.

Our analysis demonstrates that barn-owls prey 1) on proportionately more avian species and individual birds on islands than on the mainland and



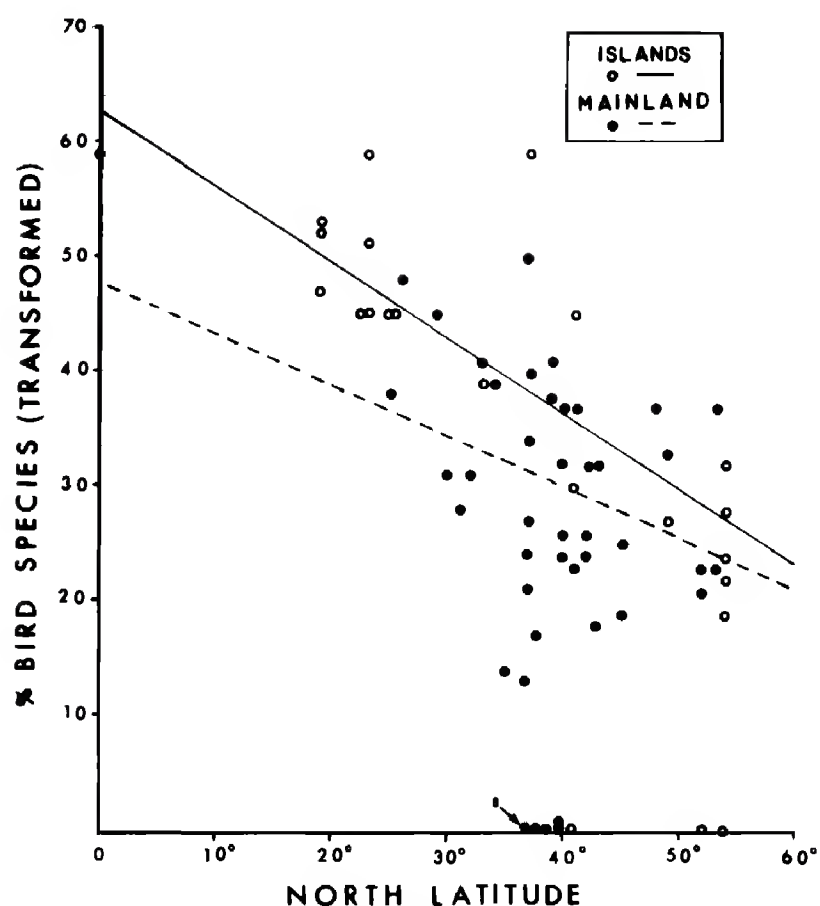


Figure 1. The relationship between degrees of north latitude and the percent of bird species among all vertebrate species of prey found in Common Barn-Owl pellets from islands and mainland sites. Percentages have been transformed (arc-sine of  $\sqrt{x}$ ; see Sokal and Rohlf 1981). Individual data points are from references cited in Table 1.

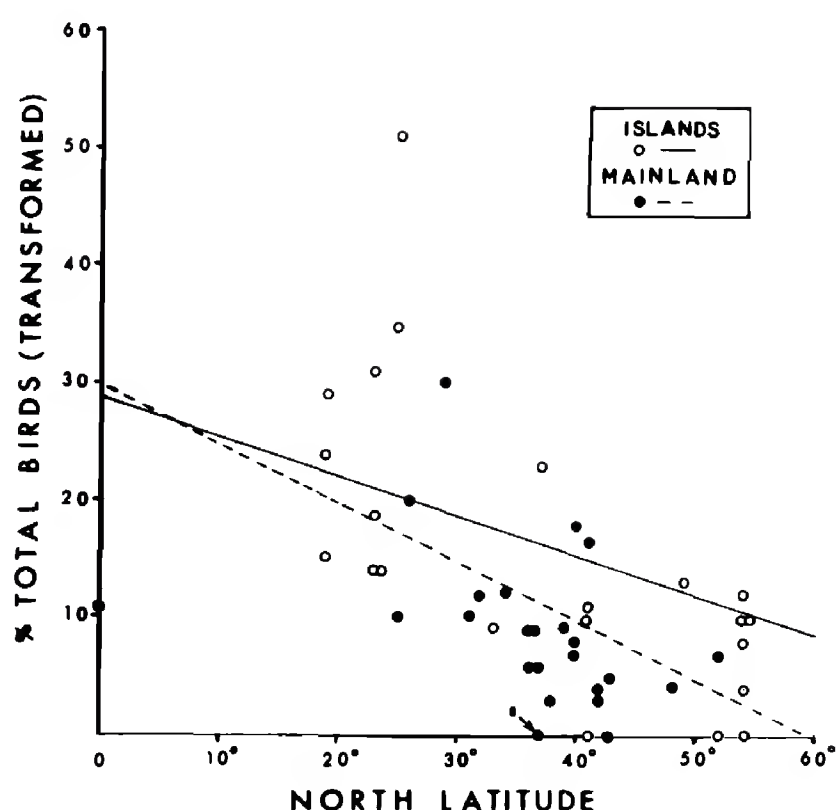


Figure 2. The relationships between degrees of north latitude and the percent of total birds among all vertebrate prey found in Common Barn-Owl pellets from islands and mainland sites. Percentages have been transformed (arc-sine of  $\sqrt{x}$ ). Individual data points are from references cited in Table 1.

2) on fewer birds with increasing latitude northward. These differences raise questions on the causes of dietary preferences. Is it because mammalian faunas on islands are more depauperate? From 11 islands for which mammal data were available, the mean number of mammalian prey species was eight, whereas the mean number from 13 mainland sites was 10, suggesting a decrease in mammalian species richness on islands. Unfortunately, a fundamental and perhaps crucial data set was lacking in all these studies, namely population densities of all available prey species. We do not have convincing evidence to know if barn-owls capture prey in proportion to the number of individuals present in the foraging area. Furthermore, we do not know the barn-owl's feeding efficiency. Is it, for example, more efficient for an owl to capture a small bird than a large rat, bat or shrew?

Finally, for our analyses of prey captured by barn-owls, it appears that this predator-prey system is at least a qualitative example of optimal foraging theory. When and if small mammal populations are

reduced in diversity or abundance on islands, barn-owls are believed to take alternative prey to maximize their energy input.

#### ACKNOWLEDGMENTS

Unpublished data were supplied by D. E. Glue, Gwilym Jones, and Karen Driscoll. James W. Haefner and Stephan R. Taub kindly offered statistical advice and earlier drafts were read by Brian Millsap, Dan Anderson, Peter Grant, Dennis Power, and Carl Marti. Their critical suggestions helped to improve the manuscript. A grant from George Mason University supported prey identifications from Block Island. We are grateful to Susan R. Drennan who collected the pellets from Block Island.

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Department of Biology, George Mason University, Fairfax, VA 22030.

Received 30 September 1986; Accepted 20 January 1987

Appendix I. Prey remains from Common Barn-Owl pellets, Block Island, RI (41°11'N, 71°34'W).

	4-5 OCTOBER 1980	1981	
		10-11 JANUARY	9-10 MAY
Number of whole pellets	26	18	16
<i>Microtus pennsylvanicus</i>	63 (51%)	42 (68%)	11 (38%)
<i>Rattus norvegicus</i>	12 (10%)	1 (2%)	6 (21%)
<i>Peromyscus leucopus</i>	46 (37%)	18 (29%)	10 (34%)
<i>Hylocichla</i> sp. <sup>a</sup>	—	—	1 (3.5%)
<i>Dumetella carolinensis</i> <sup>a</sup>	1 (0.5%)	—	1 (3.5%)
Unidentified passerine birds <sup>a</sup>	2 (1.5%)	1 (1%)	—

<sup>a</sup> Identifications by Pierce Brodkorb.

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## NOTES ON THE BREEDING BIOLOGY OF THE LONG-LEGGED BUZZARD (*Buteo rufinus*) IN BULGARIA

ILIYA TS. VATEV

**ABSTRACT.**—Observations were made on Long-legged Buzzard (*Buteo rufinus*) nests in Bulgaria between 1978–83. Egg hatching interval was 29–44 hr. First nestling plumage color was dirty-white tinged beige, cere and legs yellow; iris color changed from sepia at hatching to brownish yellow-grey at fledging. Feathers were visible by two wk. Until two wk old, nestlings assumed a “frozen” posture on their bellies when alarmed. Nestlings fed unaided by the fourth wk. Fledging began by d 49. Adults were aggressive towards humans while young were downy, but aggression lessened as young got older.

The Long-legged Buzzard (*Buteo rufinus*) is one of Europe's least studied raptors. Little detailed information on the breeding cycle of the species is available in the literature, especially with regard to its nestlings (Dementiev and Gladkov 1954; Brown and Amadon 1968; Glutz et al. 1971; Harrison 1975; Cramp and Simmons 1980). Recently, Michev et al. (1984) reported 14 definite breeding records for Bulgaria and estimated the country's population to be around 50 pairs. Also reported were notes on nest sites, egg size, breeding season and food of the species.

Herein, I report new data from Bulgaria on development and morphology of young, including hatching interval, weight at hatching, coloration of iris, bill, cere and legs, and growth of down and feathering. I also report on the behavior of adults and young and on certain other aspects of Long-legged Buzzard breeding biology.

### STUDY AREA AND METHODS

Data were collected on the nesting of the Long-legged Buzzard from 1978–83 during visits to five more easily accessible nests. Four nests were in South Bulgaria and one in North Bulgaria. Three nests were visited episodically (except for the nests in Pekliuka area). Most observations of nestlings were made at cliff-nests of a pair breeding in the Pekliuka area near Slivnitza (Sofia district) during 1981–83. Dates of visits were as follows: 9 April, 3, 14 and 16 May, and 4 June 1981; 23 May and 13 June 1982; daily during the hatch (1–4 May) and weekly on 11, 18 and 25 May and 2 June, with visits also on 21 May, and 18 and 21 June 1983. Photographs were taken and specimens of vertebrate prey were collected from the nests for identification on each of the weekly visits. On 11 and 21 May 1983 the nest was watched from a distance of approximately 800 m to record arrival times of adults with food. On 4 June 1981 the nest was watched between 0930–1900 H from a hide situated 25 m away. More frequent visits to the nest were avoided. Time spent at the site was reduced to a minimum to avoid disturbance, as the species is included in the list of endangered European birds (Hudson 1975; Michev 1986).

The Pekliuka nest was situated on a small, limestone outcrop in a shallow valley surrounded by low hills with

open plains beyond. The area is grazed by sheep and cattle attended by herdsmen. The landscape is varied by scattered thorn scrub, streamside willows (*Salix* sp.), *Carpinus orientalis* and a small conifer plantation (*Pinus nigra*). Nearest arable ground is one km away. Climate is temperate continental; av. rainfall = 592.1 liter/m<sup>2</sup> (1981–84); altitude = 7–800 m.

### RESULTS

**The Nest.** Long-legged Buzzards used the same nest at Pekliuka in 1981, 1983, and (T. Michev, pers. comm.) 1984. A new nest, relatively slight in construction, was used in 1982 on the same cliff complex approximately 350 m from the old nest (Fig. 1). Each nest was 50–60 cm dia, and both were situated on small cliff ledges. The older nest was 33–46 cm deep, and the newer nest measured only 20 cm deep. Sticks measuring  $\leq 2.5$  cm composed the base of the nest, while those in the upper layers were smaller. The nest cups were  $\leq 10$  cm deep and were composed of soft, fibrous, woody materials. Within the nest cup was found a tuft of grass roots, parts of a paper napkin, and bits of rusty wire.

Based on plumage, at least one of the adults at the Pekliuka site was judged to be the same individual in all four yr. The bird was the slightly larger one in all pairings and was thus considered to be the female, although differences in size were minimal even when pairs perched close together.

**The Eggs.** A newly laid egg weighed 70.4 g and measured  $63.7 \times 46.2$  mm. An addled egg found during the ringing of young on 13 June 1982 weighed 61.5 g and measured  $60.3 \times 47.5$  mm.

**Hatching and Growth of Young.** On 1 May 1983 one adult buzzard brooded two young, already of different sizes and in first down, and two eggs. The situation was unchanged the following day at 1300 H and 1800 H. A third young was in the nest at 0900 H on 3 May, and a fourth nestling's bill was protruding from the eggshell at 1200 H on 4 May (Fig. 2). Part of the fourth nestling's head



Figure 1. Crag nest site of Long-legged Buzzards at Pekliuka (Sofia district).

emerged shortly after. On this basis, the hatching interval at this nest was 29–44 hr. On 4 May the three young weighed 96.1 g, 61.0 g, and 48.1 g and were aged four-plus d, three-plus d, and one-d old, respectively. The fourth young, with shell still attached, weighed 59.8 g. The iris color of the nestlings was blackish-brown, and the pupil color was sepia. Bills and talons were black, and ceres, legs and feet yellow. The down was a dirty-white color with a faint beige tint above.

On 11 May, one wk after the last young hatched, only three young were found in the nest. The youngest nestling had disappeared. The remaining nestlings were now in second down, which was markedly denser and showed a slight ochre shading above. Two years earlier, on 14 May 1981, I found three nestlings in the same plumage state in this nest. On 18 May 1983 the nestlings were aged approximately 15–19-d-old. The down of the nestlings was dense and colored dirty greyish-white with an ochre tint. The tips of the first feathers were showing through

the skin on the back of the largest nestling. Iris color was dark brown and pupil color was dark grey-blue.

Rectrices, remiges, wing coverts and back feathering were showing on 21 May, and on 25 May (22–26 d post-hatch) already formed dark bands (Fig. 3). However, feathers had barely sprouted in the smallest nestling.

The nestlings had grown remarkably by 2 June (approximately 30–34-d-old) and were fully clad with feathers (Fig. 4). Iris color was a brownish yellow-grey. Back, wings and underparts were colored a chestnut brown.

When the nest was approached on 18 June the nestlings began to disperse, walking and flapping across the rock face. On 21 June the nestlings had left the nest and were calling from the cliffs nearby as one adult circled overhead. On 22 June only one fledgling was seen near the nest (T. Michev, pers. comm.). The fledgling remained at the nest-site for approximately 46–50 d and was flying at approximately 49–53 d.





Figure 2. Recently hatched chicks of the Long-legged Buzzard, and one "chipping" egg. Note Weasel as prey item in the nest.

**Behavior of Young.** On 4 May 1983, the date the last nestling hatched, the brood were extremely "tottery" and lay with their heads resting on the nest. The nestlings often fell sideways when attempting to move. The two larger nestlings made pecking movements at each other's bills, whilst fast movement of a human hand was required to induce



Figure 3. Chicks of the Long-legged Buzzard at approximately 22–26-d-old, lying "frozen" on the nest as if dead.



Figure 4. Chicks of the Long-legged Buzzard at approximately 30–34-d-old in "defensive" posture.

the larger of the nestlings to raise its head, call and open its bill. On 11 May the three nestlings (approximately 8–12-d-old) moved restlessly about the nest, calling at intervals. The nestlings panted with their bills ajar in the hot, midday sun, and the smallest nestling tried to take shelter beneath a large leaf overhanging one corner of the nest, as well as behind its largest sibling. The nestlings made no reaction to me reaching out to pick them up but glanced regularly skyward. The largest nestling was in "frozen" posture with its left foot on a small rodent (*Microtus* sp.) which had been eviscerated. Based on this evidence, the nestlings were already attempting to feed themselves on prey brought to the nest.

On 18 May I found the nestlings (approximately 15–19-d-old) lying motionless as if dead, a common behavior in western North American buteos (C. M. White, pers. comm.). Heads were pressed against the nest, and the nestlings were utterly silent and remained so even when I moved them with my hand.

Only the largest pecked at my hand. The nestlings remained still throughout my 15 min stay at the nest, although each moved their heads to follow the overhead flights of Jackdaws (*Corvus monedula*).

On 25 May the nestlings (approximately 22–26-d-old) lay “frozen” on the nest and remained silent, whereas eight d later on 2 June the nestlings moved quickly to one corner of the nest when I approached, and assumed a defensive posture. Wings were held out, and my hand was attacked with bill and talons. The two smaller nestlings lay on their backs, bills wide ajar, but attacked only with their talons. Similar behavior was shown by two well-feathered nestlings on 13 June at the 1982 nest.

On 4 June 1981 I watched the reaction of 28-d-old nestlings at the arrival of an adult with prey from a hide 25 m away. The nestlings uttered soft cheeps while the parent circled overhead. The nestlings grew quieter as the adult alighted but reached maximum intensity as the adult began feeding the young. Sometimes the adult left before the prey had been completely eaten by the nestlings, at which time the larger ones would attempt to feed themselves; the nestlings managed to do so competently at approximately four wk old.

**Food.** On sunny days the main prey was Green Lizards (*Lacerta viridis*) of different sizes. The following prey items were found on the nest: (1 May 1983) two Green Lizards and one Common Vole (*Microtus arvalis*); (4 May 1983) one Sibling Vole (*Microtus subarvalis*), one Weasel (*Mustela nivalis*) and one Green Lizard; (11 May 1983) one Common Vole and two Green Lizards. Lizards had fractured skulls or were beheaded, and the Weasel had fractured neck vertebrae.

**Behavior of Adults.** Incubation began in early April (on 9 April 1981 an adult was sitting on the nest) and ended in early May (see above) and was performed chiefly by what was presumed to be the female, relieved by its mate for brief periods only, mostly in the early afternoon. The non-incubating adult spent much of the day close to the nest site perched either on rocks where it also roosted, or on the ground. During sunny weather, mostly between 1500–1600 H, the incubating bird would rise from the eggs and stand for a few minutes on the rim of the nest. The adult would then turn the eggs with its bill and settle on them once again.

Normally at nest-relief the incoming adult carried prey, usually a small rodent. Several times I watched an interesting nest-relief ritual. The incoming adult held the prey by the tail in its bill and swung the

prey, pendulum-like, in front of its incubating mate before finally dropping the prey onto the nest. The incubating adult then rose, swallowed the prey and flew away from the nest, and the relieving adult settled to incubate.

One adult, presumably the female, was almost constantly in attendance at the nest during the first week after hatch. Later, food was brought to the nestlings by both parents. During 10-hr watches on 11 and 21 May 1983 at a distance of approximately 800 m from the Pekliuka nest, adults brought in food 13 and 21 times, respectively. Prey was carried in the talons, rarely in the bill. While nestlings were still downy, the prey was fed piecemeal to the brood by the adults. Prey larger than voles (*Microtus* sp.) was fed by the adults even after the nestlings were well grown.

People, chiefly herdsman, entered the nesting territory frequently. The buzzards displayed extraordinary wariness in their approach to the nest whenever human presence was detected. The buzzards circled and glided to and fro at relatively low altitude, often dropping to the ground. Only when the cause of the disturbance had left the area would one of the pair land at the nest, sometimes remaining on the nest rim for  $\leq 15$  min, totally still, before attending to the nestlings. If the adults noticed human approach early in the season when transporting nest material, or while carrying green boughs to lay on the nest beside the nestlings, the material was immediately dropped in flight and the adults left the area. Adults in flight would attempt to drop food onto the nest from a height of 2–4 m in response to distant activities of herdsman. Incubating adults left the nest when I approached in full view within 150–200 m from the nest, but flushed when I came within 30–40 m to the nest from around the base of the cliff.

Generally, the pair would circle 50–60 m above the cliff and call, but when I visited the nest between 1–4 May 1983 at the time of the hatch, the adults flew about and called loudly and anxiously. When I stood one m from the nest, the adults began diving at me with partly closed wings, making rushing sounds like falling rocks. The dives were made from a height of 30–35 m and were repeated several times, ending 8–10 m above my head. The “attack” of the adults was most aggressive on 11 May 1983, when one adult, probably the male, was much the bolder and came within a few meters of me. One of the adults dove at me and dropped a Green Lizard “missile-fashion,” which landed a few meters from me.



On later visits the pair was less noisy and aggressive. Usually their high circling above the nest was short-lived, and the adults would disappear from view. One adult did show itself as I retreated from the area.

**Vocalisations.** Before and during feeding, downy young uttered cheeps like young domestic fowl (Pekliuka—4 June 1981). When nests were visited which contained young, adults uttered calls resembling those of the Common Buzzard (*Buteo buteo*) but louder and more shrill.

**Nest Adornment.** After the hatch, I almost invariably found sprays of greenery lying on the edge of the nest cup. Though wilted and trodden by the young, the sprays had apparently been fresh when brought by the adults. I found flowering or leafy boughs ( $\leq 6.5$  mm dia) of the following: apricot (*Prunus armeniaca*) on 14 May 1981; common pear (*Pyrus communis*) and wild rose (*Rosa* sp.) on 4 May 1983; eastern hornbeam (*Carpinus orientalis*) on 11 May 1983; and willow (*Salix* sp.) on 18 and 25 May 1983.

#### DISCUSSION

Despite the smallness of the study sample, the relative dearth of published information on the Long-legged Buzzard's breeding cycle justifies comparison of my findings with data in print. Nests in Bulgaria are almost invariably on cliffs. Most of the 14 nests reported by Michev et al. (1984) and all the nests reported in this study were within 500 m of moving or standing water. Numbers and variety of small and medium-sized prey may thus be greater in the vicinity of water. Diameter of both nests in this study is somewhat smaller than the average value (70 m) reported by Dementiev and Gladkov (1954) for the Soviet Union.

Dimensions of two eggs measured in this study, and the values of 60.3–63.1 mm  $\times$  45.4–50.0 mm for eight eggs reported by Michev et al. (1984), are within the range reported by Cramp and Simmons (1980) but are closest to the mean for 10 eggs from Greece recorded by Makatsch (1974). The indication here is that egg dimension is uniform within the Balkan population of Long-legged Buzzards. The most common clutch size in this study was four eggs, which agrees with the findings of Dementiev and Gladkov (1954) and Michev et al. (1984).

Only three of the four eggs at each of the two nests observed in this study gave rise to flying young. The last young to hatch of the Common Buzzard

often dies through inability to compete for food with its larger siblings (Mebs 1964). On my visits to the Pekliuka nest both during and after hatching, uneaten prey was present on the nest rim, and watches from hides suggested that adults had little difficulty in securing prey. Clearly, further research is needed here. Cramp and Simmons (1980) suggest a fledging period for Long-legged Buzzards of "c. 40–42 days or more," a figure markedly exceeded by the approximate 49–53 d fledging period recorded at Pekliuka.

Michev et al. (1984) found remains of eight prey species (14 items) in pellets collected near a Bulgarian nest of Long-legged Buzzards. Two prey species, the Water Rat (*Arvicola terrestris*) and the Lesser Mole Rat (*Spalax leucodon*), were new to the spectrum of prey for the species as given in Cramp and Simmons (1980). Nine prey items of four species were found on the Pekliuka nest, of which the Weasel and Sibling Vole were new prey species to the buzzard's recorded diet in Bulgaria. Numerous Green Lizards were carried to nests in this study during sunny weather and in the study of Michev et al. (1984). Recorded prey items varied at both sites, but a preponderance of species made vulnerable by basking habits was shown. European Susliks (*Citellus citellus*) figured importantly in the diet of Long-legged Buzzards at another Bulgarian site (Michev et al. 1984).

Cramp and Simmons (1980) did not report on the role of the sexes during incubation. The brief incubation duty undertaken by what was presumed to be the male at the Pekliuka nest site reflects the pattern given for the Common Buzzard (Cramp and Simmons 1980). The nest-relief ritual observed during my study has not been reported for either the Long-legged Buzzard or the Common Buzzard.

#### ACKNOWLEDGMENTS

I am indebted to Krasimir Mihailov for his assistance on visits to some nests; to the late Nikolai Boev and Tanyu Michev of the Bulgarian Academy of Sciences for constructive criticism of the manuscript; to John Lawton Roberts who assisted with the manuscript and translation into English; to Slavcho Gerasimov of the Zoological Institute (of B.A.N., Sofia) for identification of vertebrate prey specimens; and to Dimitar Radkov of the Institute of Forestry (of B.A.N., Sofia) for identifying plant specimens from nests of the Long-legged Buzzard.

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- Department of General Biology, Medicobiological Institute, Medical Academy, 1431 Sofia, BULGARIA.**
- Received 30 May 1985; Accepted 5 January 1987

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## THE EFFECT OF VEGETATIVE COVER ON FORAGING STRATEGIES, HUNTING SUCCESS AND NESTING DISTRIBUTION OF AMERICAN KESTRELS IN CENTRAL MISSOURI

BRIAN R. TOLAND

**ABSTRACT.**—The hunting methods used by the American Kestrel (*Falco sparverius*) in relation to seven habitat types were studied in Boone County, Missouri, September 1981 through August 1984. Kestrels spent an average of 75% of each day hunting including 63% perch-hunting, 7% hover-hunting, 3.5% changing perch sites, and 1.5% in horizontal pursuit flight. Of 6359 kestrel foraging sites observed, use of disturbed grasslands was greater than expected (61%), use of croplands and woodlots was less than expected (3.5 and 4.0%), and use of old fields, undisturbed grasslands, and plowed fields was in proportion to availability. Kestrels cued on human-related disturbances in managed grassland habitat. There was no sex bias in use of habitat types by kestrels during any season. Kestrels were successful in 69.5% of their capture attempts and males were more successful than females. Invertebrates were captured most easily (82%), then rodents (66%) and birds (33%). Hunting success declined with increasing vegetation height. Hunting efficiency (estimated daily energy expenditures from time budgets and multiples of standard metabolic rate) was highest during perch-hunting. Time spent perch-hunting by kestrels decreased with increasing vegetation height. In capture/cost ratios, kestrels foraged most efficiently in disturbed grasslands, and least efficiently in old fields and croplands. Of 56 kestrel home ranges, 95% were in disturbed grassland habitat (which comprised 18% of the study area). These data suggest that the absence of suitable plant cover for kestrel foraging may effectively limit the distribution of American Kestrels in central Missouri.

Since the American Kestrel (*Falco sparverius*) is a relatively common and conspicuous raptor in Missouri (Toland 1984), inhabiting open areas and foraging along roadsides, farms and other habitats easily accessible to observers, it is a good subject for study of raptor foraging habitats. My objectives were to describe the hunting methods used by wild American Kestrels through an analysis of the relationship between vegetation height and density to foraging site selection, hunting strategy, hunting success, and nesting distribution of kestrels in central Missouri.

### STUDY AREA AND METHODS

The study area comprised 175 km<sup>2</sup> in Boone County, Missouri and was composed mainly of farmland, woodlots, old fields, and meadows, and was interlaced by gravel roads. The area was divided into seven habitat types based on vegetation height, percent ground cover, and composition. Aerial photographs by the U.S. Geological Survey (1981), and ground reconnaissance were used in measuring percentages of different habitats. Vegetation height was measured to the nearest 2.5 cm and estimated visually for comparison until no difference between the two methods resulted. This was done every two wk and habitat availability was reassessed to provide monthly as well as annual means. I calculated mean habitat availability for the kestrel nesting period (March–August). Percent ground cover was estimated by sighting through an ocular tube (four cm diameter/10 cm length; Weller 1956) pointed at the ground at arm's length. In each habitat type means from 20 readings were taken.

Croplands (wheat, corn, soybeans, etc.) made up 49% of the area. Lesser amounts of milo, oats, and tobacco were found in the study area. Three categories of croplands were recognized: 1) plowed fields, including light wheat stubble and newly planted winter wheat, 0–13 cm high comprising 25% of the study area; 2) crops, mainly wheat, corn, and soybeans 60–183 cm high, with an average ground cover of 90%, comprising 14% of the study area; 3) heavy, tall stubble 30–60 cm high, with an average ground cover of about 30%, comprising 10% of the area. Woodlots of 0.40–16.0 ha comprised 15% of the study area and had 75% ground cover. Important species included white oak (*Quercus alba*), black oak (*Quercus rubra*), hickory (*Carya* spp.), American elm (*Ulmus americana*), American sycamore (*Plantanus occidentalis*), black locust (*Robinia pseudo-acacia*), honey locust (*Gleditsia triacanthos*), persimmon (*Diospros virginiana*), and Eastern red cedar (*Juniperus virginiana*). Old fields comprised 5% of the study area. Vegetation ranged 90–254 cm in height with 95% ground cover.

Grasslands comprised 31% of the area and were subdivided into two categories: 1) idle, undisturbed pastures and meadows 60–91 cm high, with an average ground cover of 90%, comprising 11% of the study area; and 2) disturbed grasslands (mowed, and grazed pastures and harvested hay fields) 5–25 cm high where ground cover was 90%, comprising 20% of the study area.

Actual habitat use by kestrels was compared with relative habitat occurrence. American Kestrels were observed in the field for three years from September 1981 through August 1984. During the first six mo, 36 kestrels were in the study area. During the next six mo (March–August 1982) I observed 13 territorial pairs. Between September 1982 and February 1983 an average of 48 birds was in

Table 1. Relative habitat use<sup>a</sup> by American Kestrels in central Missouri.

HABITAT TYPE	HEIGHT (CM)	% GROUND COVER	% HABITAT AVAIL- ABLE	HABITAT USE	
				NO.	%
Plowed fields, light stubble, newly planted crops	0-13	10	25 (11)	681 (295)	11.0 (9.0)
Disturbed grassland and fields (mowed, hayed, grazed)	5-25	90	20 (18)	3892 (2230)	61.0 (68.0)
Heavy, tall stubble fields	30-60	30	10 (7)	340 (131)	5.5 (4.0)
Idle, undisturbed pastures and meadows	60-91	95	11 (13)	660 (393)	10.5 (12.0)
Crops (corn, wheat, soybeans, milo, oats)	60-183	90	14 (31)	228 (98)	3.5 (3.0)
Old fields, overgrown pastures and meadows	90-254	95	5 (5)	291 (66)	4.5 (2.0)
Woodlots	>300	75	15 (15)	267 (66)	4.0 (2.0)
Total				6359 (3280)	100.0 (100.0)

<sup>a</sup> During nesting season in parentheses.

the 175 km<sup>2</sup> study area. During the period March–August 1984, 50 territorial birds (25 pairs) were present. Kestrels were captured with bal-chatri traps (Berger and Mueller 1959) or noose-harnessed House Sparrows (*Passer domesticus*; Toland 1985a), and then marked with painted U.S. Fish and Wildlife Service bands and colored plastic leg bands to facilitate individual recognition.

I used a 30x spotting scope and 9x binoculars to observe each kestrel. Each bird was observed a minimum of 20 min for a combined total of 1810 hr. I recorded type of activity (perch-hunting, hovering, soaring, preening, etc.), changes of perch, and duration (sec) of all flights. Type or types of vegetation within 50 m of a hunting kestrel, hunting method, capture success, type of prey (invertebrate, small mammal, or bird), and the sex of each foraging kestrel were recorded. When unable to see prey that kestrels unsuccessfully attempted to capture on the ground, I distinguished between invertebrates and small mammals by differences in strike characteristics. Wild American Kestrels attack ground-based invertebrates from a buoyant, parachuting strike and often hop or run after an insect if the initial pounce is unsuccessful. When attacking a small mammal, however, kestrels employ a dive or stoop without breaking their momentum until the last moment (pers. observ.). These differences in hunting techniques were reinforced by the performances of 12 falconry kestrels which I trained to hunt known prey types or “bagged” quarry during four yr (Toland, unpubl. data). All hunting attempts with undetermined outcomes were excluded from analysis. I distinguished between still-hunting from a perch and other perching activity by observation of associated behaviors such as head-bobbing, sleek plumage with frequent plumage rousals (shaking), and erect,

alert posture. Observations of kestrels were made during all daylight hr including as many full days as possible. Otherwise, half-day observations were alternated in mornings and afternoons.

Birds were located by driving secondary roads. A census route of about 120 km was driven at an average speed of 40 km/hr. An average lateral distance of 800 m each side of the route was effectively covered by two observers. The area was intersected by a network of roads every 1.6 km, thus the route allowed complete surveillance of the study area. At least one census/wk was completed during three yr. Censuses were conducted between 1000 and 1400 H on days with conditions of good visibility and low wind velocity. All kestrel sites were plotted on cover maps during each of the three nesting seasons.

I estimated daily energy expenditures using observed time budgets and multiples of standard (basal) metabolic rate (SMR) (Koplin et al. 1980; King 1984) to determine differences in daily energy budgets (DEB) due to different hunting methods in vegetation of various heights. A multiple of 1.7 × SMR has been used for resting metabolic rate (RMR) (Wolf and Hainsworth 1971). This is the rate of diurnal inactive metabolism and includes SMR as well as heat liberated in thermoregulation and digestion (Gessaman 1973). Therefore, I used 1.7 as the value of the energetic cost of inactive perching and loafing. I used 1.0 as an index to the energetic cost of nocturnal inactivity (Gessaman 1973). I estimated cost of preening, stretching, eating, caching, and other maintenance activity as 2.0 × SMR. I used a multiple of 3.5 × SMR for still-hunting from a perch (Wakeley 1978b). I used 8.0 as an index to the cost of changing perching spots (Tucker 1971; Wakeley 1978b). Energy consumption during fast forward flight



used in pursuit has been estimated at  $12.5 \times \text{SMR}$  (Wakeley 1978b; Rudolph 1982). Therefore, I used 12.5 as an index to the cost of swift horizontal chases as well as hovering—kestrels compensate for the lift lost by lack of forward velocity by fanning the tail and utilizing wind and surface updrafts (Tucker 1968; Rudolph 1982). I converted prey capture rates to estimates of the number of captures/unit cost by dividing each rate by its respective energy:cost index (Wakeley 1978b). A comparison was made between these capture:cost ratios and amount of time kestrels used each hunting method and each type of habitat.

## RESULTS AND DISCUSSION

During the average 10 hr period of daylight, American Kestrels spent an average 75% of their time hunting and 25% loafing, eating and caching, and preening and stretching. Average daily activity of kestrels included 63% still-hunting, 3.5% directional change of perch, 7.0% hovering and 1.5% horizontal pursuit or tail-chasing.

**Foraging Site Selection.** I observed foraging kestrels 2131 times during the first yr, 2363 the second yr, and 1865 the third yr. The distribution of sites selected were not significantly different among the three yrs, so data were combined (Table 1).

Kestrels hunted over disturbed grasslands 61% of the time or three times the frequency with which this habitat occurred in the study area ( $\chi^2 = 84.05$ ,  $P < 0.01$ ,  $df = 6$ ; Table 1). By the same measure, kestrels significantly under-utilized crops and woodlots ( $\chi^2 = 61.6$ ,  $P < 0.01$ ,  $df = 5$ ; Table 1). Undisturbed grasslands, old fields and plowed fields were used in proportion to availability ( $\chi^2 = 1.67$ ,  $P > 0.05$ ,  $df = 2$ ).

During the nesting season (March–August) habitat availability changed substantially, croplands increasing from 14% to 31%. Kestrels exhibited even stronger preference for disturbed grassland during this season, conducting 68% of their foraging in this habitat (Table 1). During the nesting season, kestrels hunted in disturbed grassland more than expected and in crops and woods significantly less than expected ( $\chi^2 = 177.8$ ,  $P < 0.01$ ,  $df = 6$ ). Kestrel use of available old fields, undisturbed grasslands, and plowed fields did not deviate significantly from expected values ( $\chi^2 = 3.52$ ,  $P > 0.05$ ,  $df = 2$ ).

Kestrels were probably attracted to disturbed grassland, since 1) low vegetation in pastures and fields afforded good visibility of small mammals, 2) shorter, flexible grasses would give little resistance to the strike of the light-weight kestrel, and 3) dis-

turbances by farm workers, machinery and livestock would increase movement and thus vulnerability of small mammals. Shrubb (1980) reported similar behavior by the Eurasian Kestrel (*Falco tinnunculus*), which made 62% of their kills in uncultivated grasslands, roadsides, and field edges comprising 24% of a study area in England. Shrubb also reported that Eurasian Kestrels avoided cereal crops during the nesting season. His opinion was that the combination of height, density, and evenness of cereal crops inhibited successful searching, and the stiff, dense, spikey nature of the plants made prey capture difficult. A preference for haylands and pastures with good interspersed and avoidance of large tracts of cropland has also been reported for the Ferruginous Hawk (*Buteo regalis*) (Wakeley 1978a, 1978b; Gilmer and Stewart 1983), the Swainson's Hawk (*B. swainsoni*) (Bechard 1982), the Red-tailed Hawk (*B. jamaicensis*), and the Rough-legged Hawk (*B. lagopus*) (Baker and Brooks 1981). Craighead and Craighead (1956) reported higher buteo densities in habitats with shorter vegetation and sparser ground cover even though vole populations were lower.

When choosing hunting sites, kestrels in my study area were quick to cue on recently harvested crop and hay fields as well as other human-related disturbances such as plowing and mowing. These disturbances result in sudden decreases of cover and increases in rodent vulnerability. Kestrels responded so consistently to these disturbances that I was able to predict their foraging sites on the basis of farming activities. Kestrels also cue on other human-caused disturbances, such as irrigation in California (Rudolph 1982) and controlled fires in Florida (Smallwood et al. 1982). Kestrels in central Missouri commonly hunted in and around herds of livestock, apparently finding voles (*Microtus* spp.) highly conspicuous when flushed by foraging sheep, cattle or horses. Usually kestrels hovered 4–10 m above sheep but sometimes flew quickly over, around, and under grazing cattle. Shrubb (1980, 1982) found that Eurasian Kestrels in England also responded to habitat disturbances. Bechard (1982) found nesting Swainson's Hawks avoided cropland before harvest and concentrated on pastures and edge with less cover, although good concentrations of rodents were present in wheat fields. However, when harvest reduced cover, fields were extensively hunted by the hawks.

Differential use of winter habitats by both sexes has been reported for kestrels in Texas, California, Arizona, Mexico (Koplin 1973; Mills 1976), and

Georgia (Stinson et al. 1981), but was not found in Kentucky (Sferra 1984) nor in my area ( $\chi^2 = 10.77$ ,  $P > 0.05$ ,  $df = 6$ ).

**Hunting Success.** Kestrels were successful in 988 of 1414 (69.5%) capture attempts during the three yr. Hunting success was higher during the nesting period (March–June) than in winter (November–February) though the difference was not statistically significant ( $\chi^2 = 3.72$ ,  $P > 0.05$ ,  $df = 1$ ). Higher hunting success during nesting probably reflects greater prey abundance and/or vulnerability during the spring. Males were more successful hunters (72%) than females (67%) year-round ( $\chi^2 = 3.98$ ,  $P < 0.05$ ,  $df = 1$ ), but there was no difference in hunting success of males and females during winter ( $\chi^2 = 0.014$ ,  $P > 0.05$ ,  $df = 1$ ). Better hunting success by males may be an adaptation by which males provide food for both females and nestlings during much of the nesting period (Cade 1982; Toland 1986), or greater prey abundance and vulnerability during the nesting cycle when males are primary foragers may affect their higher success rates.

Kestrels in my study area had an 82% success rate in capturing invertebrates, 66% success in capturing rodents and 33% success in capturing birds ( $\chi^2 = 127.08$ ,  $P < 0.01$ ,  $df = 2$ ) (Toland 1983, 1986). During the nesting season, the overall capture rate increased to 74% of 580 attempts even though the percentage of vertebrate prey increased to 81.5% (Toland 1983). Kestrels became more aggressive and rapacious during the nesting season when it was probably more energy efficient to capture larger vertebrate prey than invertebrate prey when raising broods (Cade 1982). To investigate this phenomenon I offered handicapped European Starlings (*Sturnus vulgaris*) to kestrels during both nesting and non-nesting seasons. Although attracted to within a few m of 16 starlings offered, kestrels did not attempt to kill them during the non-nesting period. However, during the nesting season, kestrels killed 12 of 16 starlings ( $\chi^2 = 21.87$ ,  $P < 0.01$ ,  $df = 1$ ).

The overall hunting success of kestrels in my study was higher than previously reported elsewhere, perhaps due to a high density of Prairie Voles (*Microtus ochrogaster*). Voles were so abundant that they could be seen frequently in all habitats. Interviews with farmers in my study area supported this qualitative assessment. The high hunting success rate of kestrels in central Missouri is even more significant when considering that vertebrates (mainly voles) comprised 67% of the prey captured. Balgooyen (1976)

found a similar proportion of vertebrate prey (70%) in kestrel diets in California. However, most studies report higher percentages of invertebrates than vertebrates, including Jenkins (1970; 39% success, 33% vertebrates) in Costa Rica, Sparrowe (1972; 33% success, 21% vertebrates) in Michigan, Cruz (1976; 42% success, 39% vertebrates) in Puerto Rico, Collopy (1979; 55% success, 6% vertebrates) in California and Rudolph (1982; 57% success, 5% vertebrates) in California.

Height and density of vegetation in kestrel ranges had a considerable effect upon their hunting success (Table 2). With the exception of plowed fields where kestrels hunted mostly for insects and earthworms, hunting success declined significantly with increasing vegetation height ( $\chi^2 = 182.14$ ,  $P < 0.01$ ,  $df = 6$ ). The greatest number of hunting attempts (705) and captures (83%) were made in managed or disturbed grassland (5–25 cm high), while only 41% of 79 attempts were successful in crops and woodland.

**Hunting Efficiency.** Kestrels use three distinct hunting methods which vary in efficiency and energetic cost (Rudolph 1982). Kestrels still-hunt from an elevated perch 70–97% of the time (Cruz 1976; Balgooyen 1976; Cade 1982; Rudolph 1982). Kestrels hunt from a hover 2–20% of the time (Balgooyen 1976; Rudolph 1982), and in swift, horizontal flight <5% of the time. Kestrels in my study still-hunted from a perch 88% of the time and from a hover 10% of the time, while swift, horizontal flights to include tail-chasing and contour-hugging were used 2% of the time (Table 2). Vegetation height apparently influenced the hunting strategy used by kestrels. Time spent still-hunting declined with increasing height of vegetation while time spent hovering significantly increased ( $\chi^2 = 50.74$ ,  $P < 0.05$ ,  $df = 6$ ; Table 2). Since hunting methods differ in energetic costs and kestrels use them in proportions varying with the vegetation at foraging sites, vegetative structure probably influenced the ability of kestrels to maximize energy gain.

Kestrels were successful in 76% of hunting attempts from perches (Table 3), which was significantly higher than success from hover-hunting (52%) ( $\chi^2 = 55.15$ ,  $P < 0.001$ ,  $df = 1$ ) or horizontal flights (45%) ( $\chi^2 = 48.2$ ,  $P < 0.001$ ,  $df = 1$ ). I calculated capture/cost values of 22.0, 4.7, and 3.7 for still-hunting, hovering, and horizontal pursuit, respectively. The average use of these hunting methods by kestrels was roughly proportional to their respective

Table 2. Hunting strategies and success of American Kestrels foraging in seven habitat types in central Missouri.

HABITAT TYPE	HEIGHT (CM)	% GROUND COVER	% HUNTING STRATEGIES USED			HUNTING SUCCESS	
			PERCH- HUNT- ING	HOVER- ING	FLAPPING FLIGHT	CAPTURES/ ATTEMPTS	% SUCCESS
Plowed fields, light stubble, newly planted crops	0-13	10	92	7	1	67/91	74
Disturbed grassland and fields (mowed, hayed, grazed)	5-25	90	91	8	1	583/705	83
Heavy, tall stubble fields	30-60	30	81	18	1	79/122	65
Idle, undisturbed pastures and meadows	60-91	95	72	27	1	92/175	53
Crops (corn, wheat, beans, milo, oats)	60-183	90	68	30	2	28/67	42
Old fields, overgrown pastures and meadows	90-254	95	68	30	2	35/106	33
Woodlots	>300	75	92	6	2	4/12	33
Means	—	—	88	10	2	—	—
Totals	—	—	—	—	—	888/1278	69.5

capture/cost ratios. Thus, kestrels used the most efficient method (perch-hunting) most often, as previously reported by Sparrowe (1972), Collopy (1979) and Shrubbs (1982). Perch-hunting was used 91% of the time in disturbed grasslands where kestrels foraged 61% of the time with a success rate of 83%. Kestrels perch-hunted only 68% of the time in cropland and old fields and hunted only four and 6% of the time, respectively, in these two habitat types; capture success rates were 42 and 33%, respectively.

I estimated an average daily energy budget of about 60 kcal, although this value could vary with daily temp or season, and body weight of the birds (Koplin et al. 1980). During the nesting season, when adults in central Missouri are usually feeding five nestlings (Toland 1985b), it becomes increasingly obvious why kestrels hunt in habitat where

they can forage most efficiently. Of 56 nesting season home ranges, 95% (all but three) were in disturbed grassland habitat. Thus, most of the nesting kestrels in my study area were concentrated in 18% of the available habitat. As vegetation increases in height, detection and capture of prey become more difficult. Because the prey animal is vulnerable to predation only for brief moments, kestrels foraging in these habitats must depend on hunting methods which afford close proximity to prey. These methods include hovering and horizontal flight during contour-hugging or tail-chasing, and are energetically at least four times more costly than perch-hunting, which may explain why kestrels spend so much time foraging in habitat where they mostly still-hunt from perches.

The importance of habitat physiography is com-

Table 3. Success of American Kestrel hunting strategies 1981-83.

SEX	STILL-HUNT		HOVER		TAIL-CHASE	
	CAPTURES/ ATTEMPTS	%	CAPTURES/ ATTEMPTS	%	CAPTURES/ ATTEMPTS	%
Males	478/611	78	80/141	57	34/69	49
Females	333/451	74	48/103	47	15/39	38
Total	811/1062	76	128/244	52	49/108	45



pounded during the nesting season when adult American Kestrels must provision five or six nestlings whose daily energy requirements exceed adults (Cade 1982). This critical time period demands that kestrels forage as efficiently as possible, and could explain why 95% of the nesting pairs had home ranges composed of disturbed grasslands. The scarcity of suitable plant cover effectively limits the distribution of American Kestrels in central Missouri and may explain declines of several species of hawks in areas where expansive monoculture farms predominate.

#### ACKNOWLEDGMENTS

William H. Elder, School of Forestry, Fisheries and Wildlife, University of Missouri, Columbia, provided guidance throughout this study. Nancy Thompson-Toland contributed financial, moral and field support. I appreciated field assistance from David Scarbrough, Toney Chiles, and Tim Haithcoat. Thomas S. Baskett, Curtice Griffin and James R. Koplin provided criticism of an earlier draft of the manuscript. Helmut C. Mueller, Clayton M. White, Peter Bloom, and an anonymous referee made editorial comments that improved the paper. This study was funded by the Natural History Section of the Missouri Department of Conservation.

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- Department of Forestry, Fisheries and Wildlife, 112 Stephens Hall, University of Missouri, Columbia, MO 65211. Present address: Florida Game and Fresh Water Fish Commission, P.O. Box 1840, Vero Beach, FL 32961.**

Received 10 July 1986; Accepted 12 January 1987

**Research/Teaching Assistantship Wanted.** Serious raptor student seeking M.Sc. research/teaching assistantship to begin Fall 1987. Interested in virtually any aspect of raptor ecology or behavior, especially raptor-prey ecology, habitat requirements, and population modeling. Willing to consider almost any locality, but prefer western U.S. or Mexico. Have B.S. in Wildlife Science, published research, and a variety of experience. GRE scores, transcripts, recommendations, etc., available. **Please contact: Bryan Kimsey, P.O. Box 278, Anahuac, TX 77514, (409) 267-6527.**

**Newly-Appointed Vice President of the Society for the Preservation of Birds of Prey.** The Reverend Edward D. McGinnis of Elizabeth City, North Carolina, was named Vice President of the Society for the Preservation of Birds of Prey on 29 December 1986. Reverend McGinnis was born in Durham, North Carolina, and received his B.A. degree in religion and philosophy from Elon College in 1969. **He can be contacted at P.O. Box 2448, Elizabeth City, NC 27909.**

## RAPTOR CARE AND REHABILITATION: PRECEDENTS, PROGRESS AND POTENTIAL

JOHN E. COOPER

**ABSTRACT.**—Over the past two decades much has been learned about the care and treatment of raptors. Nursing, therapy, rehabilitation and release all necessitate specialized skills, coupled with an understanding of the biology and needs of the patient. Clinical work must be augmented by necropsy of carcasses, eggs and embryos.

Future developments will include diagnostic and therapeutic aids, advances in captive breeding, better collation of information, a more analytical approach to data, closer collaboration between different disciplines and the extension of existing knowledge to conservation projects. Public attitudes to animals are also changing and raptor biologists must be prepared to respond appropriately.

Birds of prey have been used for falconry for many centuries, and as a result, there is a long history of recognition and treatment of raptor diseases. An early Arabic treatise (A.D. 775-785) discussed this topic and the reader was advised: "Do not change the disease through medicines before its recognition and diagnosis. But ascertain and investigate until you understand the disease. As soon as you are firmly convinced of your diagnosis quickly start the treatment . . . ." (Cooper 1979).

The first written account of raptor diseases in English is to be found in the "Boke of St. Albans" (Berners 1486). Subsequently many authors discussed the various ailments to which hawks were prone and treatment (both medical and surgical) was advocated. Examples are given in Cooper (1979). Very few significant advances appear to have been made and many mediaeval cures were still being recommended in the late 19th and early 20th century. The first major breakthrough was probably in 1948 when Dr. R. M. Stabler elucidated the aetiology of "frounce" (Stabler 1954). From 1960 onwards there was an upsurge of interest, prompted mainly by concern over pesticides and the decline of a number of species. There was a gradual increase in awareness by veterinarians of the significance of raptors. Scientific publications on disease began to appear and authors started to advocate the use of modern drugs.

My own involvement in birds of prey can be traced to my boyhood interest in the natural history of raptors and falconry. When I entered veterinary school in 1962 I started to study raptor anatomy and

in 1965 included *post-mortem* examinations and attempts at diagnosis. Following graduation I extended my research to include clinical investigations both in Britain and East Africa, where I worked from 1969-73. In 1978 I published some of my data in "Veterinary Aspects of Captive Birds of Prey" (Cooper 1978). This was followed by other publications—for example, the excellent section on birds of prey in "Zoo and Wild Animal Medicine" (Fowler 1978) and a number of scientific papers from both sides of the Atlantic. In 1980 an International Symposium on the Diseases of Birds of Prey was held in London. This was a chance to bring together those interested in pathology and disease and to exchange views and information. The Proceedings, consisting of papers by specialists, were published (Cooper and Greenwood 1981).

Over the past five years the subject has expanded. The establishment in many parts of the world of raptor centres has involved an increasing number of veterinarians and biologists in the treatment and rehabilitation of sick and injured raptors. Much information gained is still unpublished, but there are opportunities to disseminate and share it at conferences and meetings.

There is a clear need for veterinary attention for captive birds, for example, in zoos and for falconry, but there are those who argue against care and attempted rehabilitation of free-living raptors. I do not share this view and believe that treatment can be justified on four grounds: 1) legal, 2) humanitarian, 3) scientific, and 4) conservation. These four views will be discussed briefly.

Insofar as the legal situation is concerned, in Britain the tending of casualty birds is permitted by law (the Wildlife and Countryside Act of 1981) (Cooper 1986), and the killing of a casualty which might have recovered may constitute a legal offence. Sim-

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Keynote address at the session on Rehabilitation and Captive Breeding, International Symposium on the Management of Birds of Prey, Sacramento, CA, November 1985.



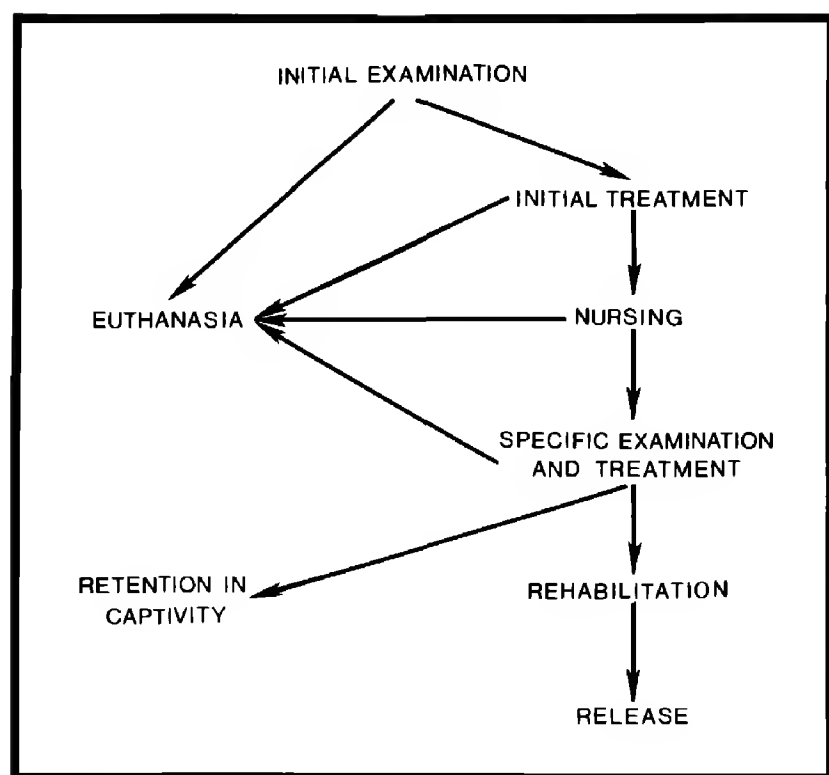


Figure 1. An outline for the treatment of raptor diseases.

ilar protection is afforded to raptors in many other parts of the world. The taking and care of sick or injured birds is strictly regulated in some countries and states/provinces (particularly in North America), but elsewhere there is little specific control.

Humanitarian considerations dictate that a sick or injured raptor should either be killed or treated. It is important that the welfare of the bird is the prime consideration but this can sometimes pose a moral dilemma (Cooper and Eley 1979). There is little doubt that considerable scientific benefit may be obtained from the treatment and rehabilitation of raptors. Much progress in veterinary care over the past 10–15 yr is due to work on such birds (Cooper and Greenwood 1981; Duke et al. 1981).

The contribution of raptor rehabilitation to conservation is debatable. Many argue that releasing relatively small numbers of birds to the wild contributes nothing to the species' status and in some cases could even be counterproductive. However, the indications are that, in the case of the Bald Eagle (*Haliaeetus leucocephalus*) in the United States and the Northern Goshawk (*Accipiter gentilis*) in Britain, rehabilitation programmes may have played a part in bolstering wild populations. In addition there are the indirect benefits of such work—for instance, the availability of casualties for captive breeding programmes and the enormous educational impact of birds which cannot be returned to the wild but which can be viewed and handled by the public.

**Practical Aspects.** The care of casualty raptors can be broken down as nursing, therapy, rehabilitation, and release. Each is an integral part of the process and yet each requires special skills and facilities. Expertise varies and the same person may not be involved in all aspects. A team approach is desirable. The four headings will be discussed in turn.

**Nursing.** As seen in Figure 1, nursing occupies a central position. Successful nursing requires knowledge of the biology and needs of the patient. In Britain and North America there are many wildlife rehabilitators who are extremely skilled and who appreciate the need for a “holistic” approach to the bird and its problems. Nursing can be defined as “tending (a sick person or animal), trying to cure” and the emphasis is on supportive care, such as provision of warmth and hand-feeding, rather than specific diagnosis and treatment.

**Therapy.** Strictly this is the domain of the veterinary profession. In the past there has been a shortage of veterinarians with interest in and experience of non-domesticated birds, but the situation has greatly improved in recent years. It is important that the rehabilitator and veterinarian work together, each contributing his/her own expertise. There have been enormous advances in the diagnosis and treatment of raptors and many of these are described in standard texts (e.g., Cooper and Greenwood 1981; Fowler 1978, 1985). The role of laboratory investigations and necropsy cannot be overemphasised as they supplement clinical work and help provide a more accurate diagnosis.

Treatment can be divided into surgery, chemotherapy and attention to management. Major advances have been made in surgical techniques and orthopaedic, ophthalmological and abdominal operations are now regularly performed (Harrison 1984; Coles 1985). Such work has been facilitated by the development and use of new anaesthetic techniques (Harrison and Harrison 1986; Samour et al. 1984). Likewise, many modern chemotherapeutic agents are used. However, more study is needed on the efficacy and safety of drugs in birds. A few have been investigated employing birds of prey such as gentamicin in the Great Horned Owl (*Bubo virginianus*) (Bauck and Haigh 1984; Bird et al. 1983) and amphotericin B in a range of species (Redig and Duke 1985). Others have been tested in pigeons prior to clinical use in raptors (Cooper 1985), but many remain unproven. Management changes can

play an important part in the prevention and treatment of disease, such as the correction of poor perching and improvements to ventilation following the use of settle plates or smoke tests to detect deficiencies (Cooper 1978).

**Rehabilitation.** Rehabilitation is different from release. The Concise Oxford Dictionary defines rehabilitation as "restore to privileges, reputation or proper condition; restore to effectiveness by training (especially after imprisonment or illness)." In many ways rehabilitation is an extension of nursing—the "holistic" approach whereby one is endeavouring to improve both the physical and psychological well-being of the patient. Although there are some published works on this subject (e.g., Cooper and Eley 1979; Redig 1978; Llewellyn and Brain 1983) there remains a need for an authoritative volume compiled by those who are most experienced.

**Release.** The Concise Oxford Dictionary defines release as "set free, liberate, deliver, unfasten (from)." Release is the final stage of care, the point at which the raptor is liberated. Contact may be maintained (see later) but essentially the bird is independent and having to cope with what is often a relatively unfamiliar and hostile environment. Rehabilitation and release may overlap, especially if a bird is being hacked back. The successful return of a bird to the wild is not an easy matter and may pose more problems than nursing and therapy. In particular it often proves difficult to assess whether or not a casualty bird is fit for release. A number of authors have addressed themselves to this and although there are some differences of opinion, many points are generally accepted. Cooper et al. (1980) listed four considerations when assessing whether a bird should be liberated. These were 1) the physical and psychological health of the bird, 2) its relationship with man, 3) the locality for release, and 4) time of year, climate, etc. Prior to release, birds should not only be examined clinically but also screened for evidence of pathogens or underlying health problems. A routine screening programme, which is adapted from Cooper and Greenwood (1981), is depicted in Figure 2.

Despite a few studies and publications on the subject (e.g., Duke et al. 1981) the assessment of the fate of released birds remains a hurdle. All raptors which are returned to the wild should be banded, and colour marking may assist subsequent identification. Telemetry permits a bird's progress to be monitored but is an expensive and time-consuming

- A) PHYSICAL EXAMINATION

  - a) CLINICALLY HEALTHY
  - b) FREE OF SIGNIFICANT INJURIES, LESIONS AND ECTOPARASITES

B) LABORATORY TESTS

  - a) MUTES
    - i) FREE OF PARASITES
    - ii) NO EVIDENCE OF *Salmonella* OR OTHER SIGNIFICANT ENTERIC PATHOGENS
    - iii) NO ACID-FAST ORGANISMS (*Mycobacterium* spp.) IN SMEARS
  - b) BLOOD
    - i) NO PARASITES OR SIGNIFICANT ABNORMALITIES IN SMEARS
    - ii) PCV (haematocrit) WITHIN NORMAL LIMITS
    - iii) PLASMA PROTEIN WITHIN NORMAL LIMITS

Figure 2. A screening programme for raptors prior to release.

procedure. Re-trapping of released raptors will enable them to be weighed, examined clinically and screened. A small study on re-trapped Black Kites (*Milvus migrans parasitus*) in Kenya showed considerable variation in condition even though all birds were receiving a food supplement (Cooper 1977). Duke et al. (1981) reported recoveries and resightings of a number of species which had been released following treatment. More extensive studies are urgently needed.

**The Future.** Despite many advances, much remains to be learned. It seems likely that future developments will be primarily in the following and as discussed beyond; 1) increased specialisation, 2) more sophisticated technology, 3) extension of existing knowledge and techniques, 4) greater manipulation of birds, and 5) closer association with conservation.

**Increased Specialisation.** In 1978 it was possible for one person to write a book on diseases of raptors. Currently, it would be more prudent and satisfactory if individuals were to contribute chapters on their own speciality. While most veterinarians involved with raptors retain general interests, some have made a particular study of clinical problems such as orthopaedics or parasitic diseases, while others have

tended to concentrate on microbiology or pathology. Such specialisation, however, brings with it the danger of less collaboration and, ultimately, the fragmentation of the discipline.

**More Sophisticated Technology.** It can be safely assumed that developments in veterinary medicine will be mirrored in work with raptors. Insofar as diagnostic procedures are concerned, the following techniques are amongst those that are likely to develop and be utilised more fully: a) radiography—especially contrast studies; b) endoscopy—rigid and flexible; c) ultrasound; d) computerised axial tomography (CT scan); and e) nuclear magnetic resonance (NMR). Some have already been employed. For example, Furley and Greenwood (1982) reported the use of wholebody (CT) scanning in the diagnosis of aspergillosis in falcons in the Middle East. Other techniques have still to be investigated and, if possible, adapted to work with raptors. Therapeutic procedures are likely to develop on similar lines and amongst those that will undoubtedly prove of increasing value in raptor work are endoscopic procedures, cryotherapy, laser surgery and radiotherapy. Homeopathic remedies and acupuncture have been advocated but have attracted little attention to date.

**Extension of Existing Knowledge and Techniques.** Despite advances of the past few years, many opportunities have been overlooked. For instance, there appear to be only two studies on the normal embryonic development of raptor species; the American Kestrel (*Falco sparverius*) by Bird et al. (1984) and on the Pariah Kite (*Milvus migrans govinda*) by Desai and Malhotra (1980). Likewise, with a few notable exceptions (e.g., Burnham et al. 1984) very little has been published on “normal” eggshell size and thickness and yet many thousands of falcon eggs have been produced and some are presumably available for study.

Other pathological data are urgently needed. For instance, organ weights and organ/body weight ratios are important in toxicological studies in other species and have been investigated in seabirds (Osborn and Harris 1984). They should be a routine part of raptor *post-mortem* examinations to help ensure a more analytical approach. Clinicopathological case reports still have a part to play but detailed analyses of larger numbers of birds, preferably in controlled studies, are required.

An important way of promoting extension of existing knowledge is by organising multidisciplinary

conferences and encouraging the publication of papers. In addition, however, there is a need for information to be shared more freely and for the establishment of a data base, preferably on computer, so that raptor biologists can have quick and easy access to both published and unpublished material.

**Greater Manipulation of Birds.** Already raptors are being manipulated in order to obtain more information or benefit from them. Examples include artificial insemination, double clutching, hand-rearing and cross fostering (Olney 1984). More invasive procedures, such as the experimental production of disease, toxicological investigations and the implantation of cannulae are becoming more frequent (Cooper 1978). While such studies have already yielded some useful information we must be aware that, unless carefully controlled, manipulations can become mutilations and birds may suffer. The extent to which the latter are acceptable will depend upon the purpose of the study and this may necessitate a careful and sensitive assessment of the cost benefits. In a rehabilitation centre invasive procedures have no place and such investigations should be reserved for the research laboratory. Those working with raptors should be aware of the increasing numbers of people, notably members of animal rights movements, but also including a growing proportion of the general public, who view the exploitation of animals with concern. There is no clear-cut solution to this conflict of interests but one important way to help ensure a humane approach is to have a code of practice at each centre and to follow it when raptors are treated, rehabilitated, bred or used. Various guidelines are available; for example, those produced in Britain by the Biological Council (Anon. 1984) and in Canada by the Canadian Council for Animal Care (Anon. 1980–84). A humane approach to animals is not new. As long ago as the fourth century, St. Chrysostom (A.D. 347–407) wrote: “Surely we ought to show them (animals) great kindness and gentleness for many reasons, but, above all, because they are of the same origin as ourselves” (Hume 1957).

**Closer Association with Conservation.** Much knowledge gained from the care of sick and injured raptors and from investigation of morbidity and mortality can be applied to conservation. Collaboration between veterinarians and biologists in Britain has greatly enhanced investigations into native birds of prey. For instance, sickness and deaths in free-living Northern Goshawks were recently traced to out-



breaks of trichomoniasis (Cooper and Petty 1987). Studies on the Merlin (*Falco columbarius*) and Common Barn-Owl (*Tyto alba*), both declining in Britain, are in progress and those involved include veterinarians and wildlife rehabilitators as well as field biologists. In some areas the submission of dead owls and hawks for necropsy prior to toxicological investigation has permitted the diagnosis of a number of conditions which might well otherwise have been missed. At the same time the possible interaction between toxic compounds and infectious agents (Kende et al. 1984) can be better evaluated.

It is probably in Third World countries, in areas where raptors (and other species) are facing grave threats, that application of knowledge is most needed. I am fortunate enough to be involved in several projects where raptors are being tended in captivity and, in a number of cases, used for captive breeding. Thus, tissues for pathologic examination have been received from Philippine Eagles (*Pithecophaga jefferyi*) which have died at the captive breeding project at Manao. Eggs of this species which have failed to hatch have been sent, under permit, to my laboratory for necropsy and following our investigations we have forwarded them to Ian Newton for toxicological analyses. This combined approach has not only provided valuable data on the morphology of these eggs but also revealed the presence of significant levels of chlorinated hydrocarbon insecticides.

The longest and most intensive veterinary input has been on the Mauritius Kestrel (*Falco punctatus*). I have been an advisor to the Mauritius Conservation Project since its inception in 1973 and over the 12 yr period have been able to advise on clinical problems, examine pathological material and introduce a screening programme (Cooper et al. 1981). A visit to the island in December 1984 permitted the extension of this work to encompass the pathologic examination of infertile unhatched eggs and the monitoring of the captive breeding facilities for environmental contamination. There is strong evidence that bacterial infection may have caused the death of some embryos and a rigid programme of hygiene has been drawn up for the project. Veterinary advice of this kind, based as it is on experience with raptor centres and captive breeding units in Europe and North America, could provide a valuable input to other programmes.

**Conclusions.** The study of raptor diseases and rehabilitation is now a recognised and *bona fide* discipline. Much has been achieved, but a great deal

more remains to be learned and put into effect. In the past there have been too many barriers between those who work with captive raptors and those who are concerned with the conservation of these birds in the wild (Cooper 1983). There has also been a lamentable absence of dialogue and collaboration between biologists, veterinarians, rehabilitators and others. A clear need exists for closer cooperation. We must be willing to pool resources and to share with others both our achievements and our failures. The need for greater interchange between the Western and Eastern Hemispheres and between developed and developing countries has never been greater. If we work together, those of us concerned with raptor care can make a substantial contribution to the conservation and management of some of the world's most magnificent and inspiring birds.

#### ACKNOWLEDGMENTS

I am grateful to The Raptor Research Foundation, Inc., and the San Francisco Zoological Society for inviting me to speak at the Conference and for providing financial assistance, and to Andrew Greenwood for reading and commenting on this paper.

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**Department of Pathology, Royal College of Surgeons of England, 35-43 Lincoln's Inn Fields, London WC2A 3PN, ENGLAND.**

Received 25 July 1986; Accepted 5 January 1987.

## HABITAT SELECTION AND BEHAVIOR OF NESTING BALD EAGLES IN LOUISIANA

JAMES O. HARRIS, PHILLIP J. ZWANK AND JOSEPH A. DUGONI

**ABSTRACT.**—Habitat selection and behavior of nesting Bald Eagles (*Haliaeetus leucocephalus*) in Louisiana were investigated from December 1977 to May 1980. Twenty-nine nests that were thought to represent 12 occupied and four unoccupied breeding areas were surveyed. Most (93%,  $N = 27$ ) nests were in old, large, baldcypress trees (*Taxodium distichum*), with much of the surrounding area in marsh or swamp. Behavior of nesting eagles was observed at three nests. Over 75% of activity occurred at the nest, over marsh and over swamp. Over 60% of activity consisted of perching or straight-line flight.

Currently about 29 pairs of Bald Eagles (*Haliaeetus leucocephalus*) nest in Louisiana (unpubl. data, 1985-86 nesting season, Fred Bagley, U.S. Fish and Wildl. Serv., Jackson, MS). The bird is now listed as an uncommon resident (Lowery 1974), but during the early 1900s it was reportedly a common resident over most of Louisiana, particularly near southern water bodies (Bailey 1919), and on the Mississippi River delta (Allen 1936).

Within the nesting range, drainage, channelization, exploitation of baldcypress/tupelo-gum (*Nyssa aquatica*) forest type, marshland conversion to agriculture, and oil, gas, industrial, and residential development continues. The effects of these activities on nesting Bald Eagles in Louisiana are not documented but may be detrimental (Snow 1973). Information on nesting habitat selection and behavior may be of assistance in reducing adverse effects. The objectives of this study were to describe nesting habitat and behavior of selected nesting pairs of Bald Eagles in Louisiana.

### STUDY AREA

The study was conducted in the coastal region of south-central and southeastern Louisiana (Fig. 1). The area is at low elevation and consists primarily of permanently to seasonally flooded, second-growth baldcypress/tupelo-gum swamps and backwater areas with associated marsh, bayous, canals, ponds, lakes, and rivers. Plant species vary with drainage patterns, elevation, and biotic and edaphic factors and are described by Chabreck (1972).

### METHODS

**Nest Site Characterization.** Terminology follows that given in Swenson et al. (1986). A breeding area was an area containing  $\geq 1$  nest within the range of one mated pair of birds. An occupied nest was one at which a mated pair of eagles was present at the nest, had repaired the nest, and/or had laid eggs. An active nest was an occupied nest in which eggs were laid. An alternate nest was an

unoccupied nest within the breeding area of one pair of eagles.

All known breeding areas (unpubl. data, U.S. Fish and Wildl. Serv.) in the study area were visited to determine nest tree species. Nest tree diameter, condition (living or dead), and height were recorded.

Concentric circles of 1.6-, 3.2-, and 4.8-km radii were drawn around known breeding areas on 15-min series U.S. Geological Survey topographical maps. Recent (1978) color infrared photographs were used to update the topographical maps relative to any habitat alterations that occurred since the date of printing. Habitats that could be interpreted from infrared photographs were open water lakes, marsh ponds, bayous, pipeline canals, cypress-tupelo swamps, marshes, pipeline rights-of-way, and industrial/residential developments. The first four types were considered aquatic habitats, while the remainder were considered terrestrial habitats, even though swamps, marshes, and pipeline rights-of-way may be permanently or seasonally flooded. Sizes of habitat types existing within specified radii around each nest were determined by using a planimeter.

Percent cover of the habitat types within 1.6-, 3.2-, and 4.8-km radii of nests and percent cover of terrestrial and aquatic habitats were compared between breeding areas using unpaired t-Tests (Steele and Torrie 1980).

**Observation of Nesting Pairs.** Three Bald Eagle breeding areas that had been active during the 1976-77 nesting season (South Bayou Chene, Paradis and White Kitchen) were chosen for observation of eagle behavior during the 1977-78 and 1978-79 nesting seasons. The habitat around Bayou Chene nest was a mix of marsh and swamp. The White Kitchen nest was located in an area dominated by marsh and swamp with little open water. The Paradis nest was situated on the edge of a baldcypress/tupelo island with few mature trees, and was surrounded by water and marsh. The Bayou Chene and Paradis breeding areas each contained two nests, and the White Kitchen area had one.

Prior to observation, the three breeding areas were reconnoitered to locate nests, to ground-truth habitat information from photographs and to determine approximate eagle activity patterns. At each site, an observation blind was constructed prior to arrival of nesting pairs. Blinds were constructed within 100 m of the nest to afford a good view of daily eagle activity with binoculars and spotting



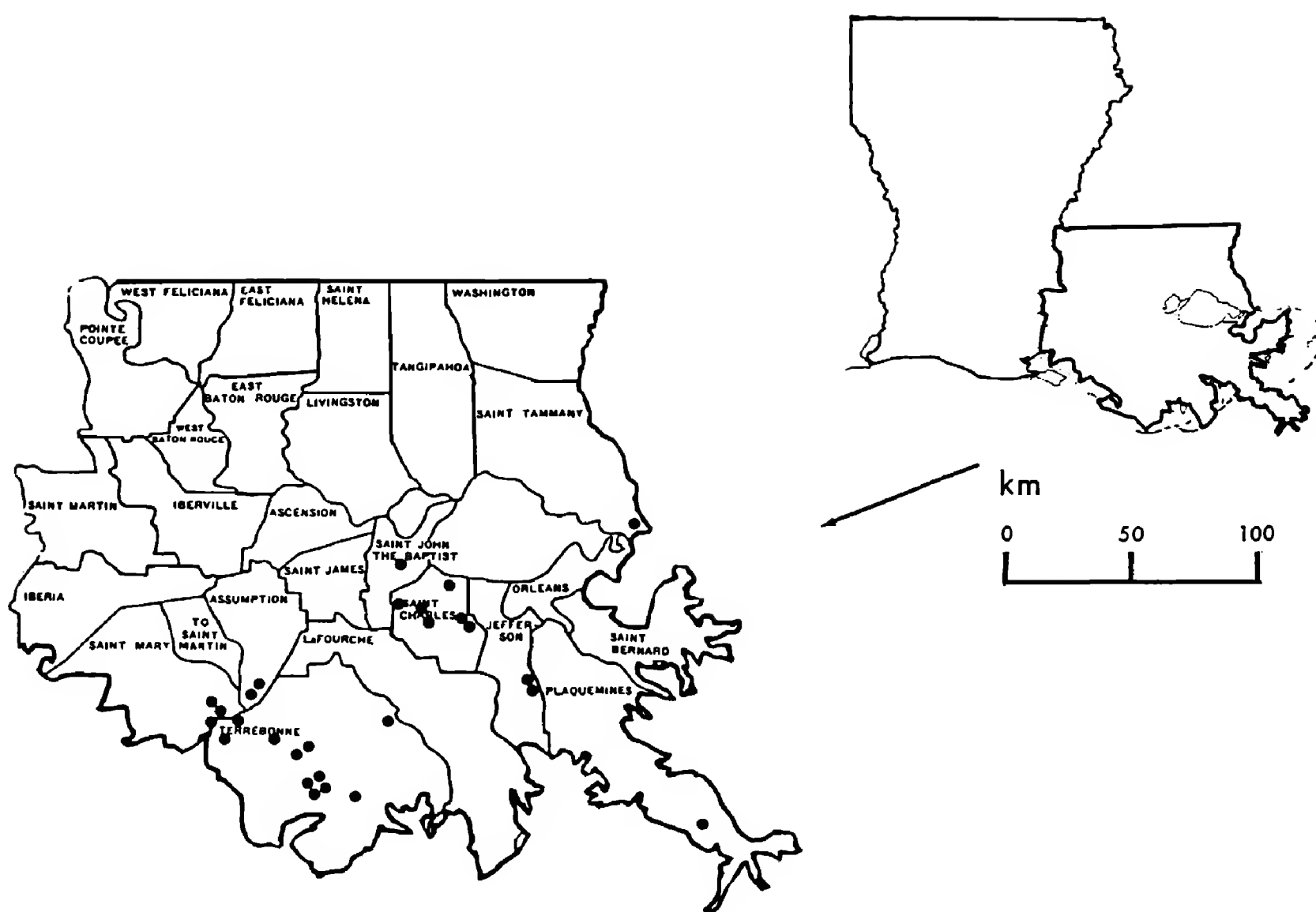


Figure 1. Known locations of Bald Eagle nests in southcentral and southeastern Louisiana in 1976-77.

scopes. Observations were made at least 2x/wk from the time eagles arrived in September-October until young fledged in April-May. Observations were made from dawn to dusk except when fog or severe weather conditions made observations impossible. Data recorded included number of eagles sighted, location, time of initial observation and time when lost from sight, habitat in which observation occurred, and eagle activity. Observations were primarily of adult eagles. Duration of a sighting was initiated when an eagle was first observed over any habitat and terminated when habitat and/or activity changed or when the eagle was lost from view.

Eagle activities were recorded as occurring at the nest or over marsh, swamp, lake, open water, bayou or canal. Activities were categorized as foraging, soaring, combined foraging and soaring, straight-line flight, aggressive behavior, perching, courtship, and other. The other category included feeding, preening, and other less frequently observed activities.

## RESULTS

**Nest Site Characterization.** During the study, 29 nests thought to represent 12 occupied and four unoccupied breeding areas were surveyed (Fig. 1).

We classified six (20%) as alternate nests. Twenty-seven of 29 nests in this study were situated in bald-cypress trees (24 in live trees and three in dead trees). The remaining two nests were in dead live-oaks (*Quercus virginiana*).

All nests but one were in dominant or co-dominant trees, often on a habitat interface adjacent to aquatic habitats. Typically, nest trees had broken tops and an enlarged uppermost whorl of branches that provided a platform for the nest structure.

Incidence of nest loss, particularly due to storms and lightning, was substantial. Approximately 11% of occupied nests were destroyed annually during the course of this study.

Habitats near active nests were highly variable, with swamp being the only type found in the immediate vicinity of all nests (Table 1). Swamp also provided a large percentage of habitat within 1.6-, 3.2-, and 4.8-km of all active nests (Table 1). Swamp also provided a large percentage of habitat within the sampled areas. Marsh was the other major hab-

Table 1. Mean and (range) in percent of coverage by eight habitat types within 1.6, 3.2, and 4.8 km of 23 occupied Bald Eagle nests in southcentral and southeastern Louisiana, June 1979.

RADIUS (KM)	TERRESTRIAL				TOTAL
	SWAMP	MARSH	PIPELINE RIGHT-OF-WAY	DEVELOP- MENT	
1.6	36.8 (2.0-93.2)	36.8 (0-71.3)	1.0 (0-4.9)	6.4 (0-32.2)	80.5 (25.8-98.1)
3.2	30.9 (4.1-89.9)	37.2 (0-73.0)	0.6 (0-3.8)	8.3 (0-31.0)	76.9 (31.2-96.0)
4.8	29.9 (2.7-80.9)	35.4 (0-62.8)	0.5 (0-3.4)	8.6 (0-26.9)	74.5 (29.4-96.9)
RADIUS (KM)	AQUATIC				TOTAL
	LAKE	MARSH POND	BAYOU	PIPELINE CANAL	
1.6	8.2 (0-37.8)	6.5 (0-74.2)	3.5 (0-11.4)	1.3 (0-5.0)	19.5 (1.9-74.2)
3.2	11.2 (0-38.6)	7.2 (0-62.0)	4.1 (0-22.5)	1.4 (0-9.2)	23.1 (4.0-68.8)
4.8	13.0 (0-34.8)	7.8 (0-49.8)	3.4 (0.2-14.6)	1.3 (0-4.8)	25.5 (3.1-70.6)

itat type at all distances measured. None of the aquatic habitat types contributed more than 10%. Coverage by developments ranged from 0.0-32.3% within 1.6-km of the nests and changed little as distance increased from the nest.

The relative percentages of habitats did not change ( $P > 0.10$ ) as distance from the nest increased from 1.6- to 3.2- and 4.8-km. Additionally, the relative percent of aquatic and terrestrial habitats remained consistent around nests (Table 1), and this relationship was similar for all distances measured ( $P > 0.10$ ).

**Observation of Nesting Pairs.** During 2000 hr of observations during two nesting seasons, 1745 sightings of adult Bald Eagles were made, classified, and recorded. Overall, 69.8% of the sightings occurred in the Bayou Chene breeding area, 19.8% at Paradis, and 10.4% at White Kitchen.

Analyzed by location, 28% of the observed activity occurred at the nest, 27% over marsh, and 28% over swamp (Table 2). All percentages dealing with eagle activity refer to percent total time observed. Perching and other were the primary activities at the nest. Eagle activities over marsh consisted mostly of foraging and straight-line flight. Perching and

straight-line flight were the major activities over swamp.

Of observed activity by behavior type, 32% consisted of straight-line flight and 32% perching (Table 2). Straight-line flight was usually observed over swamp, marsh, or in flights to and from the nest. Perching was usually observed in trees in the swamp near the nest or at the nest. Foraging for food and soaring each accounted for approximately 10% of activity. Approximately 1% of activity was courtship and aggressive behavior. Courtship and soaring usually occurred over aquatic, open habitats.

Large parts of the breeding areas were not visible to the observer at any time. Therefore it was impossible to accurately estimate what habitat was being used at all times. Within the area visible to the observer, eagles of the Bayou Chene nest were observed the majority of the time (43%) over marsh habitat (Table 3). Around this nest, nearly ½ (43%) of the available habitat within a 4.8 km radius was marsh. Although little of the visible activity occurred over swamp (<0.1%), 20% of the habitat within 4.8 km of the active nest was swamp. Activity around the White Kitchen nest was greatest over the swamp habitat (67%), which makes up about ½ (47%) of the available habitat within a 4.8 km ra-

Table 2. Mean percentage of Bald Eagle activities that occurred over various habitat types near three nests in Louisiana during the 1977–78 and 1978–79 nesting periods.

ACTIVITY	NEST	MARSH	SWAMP	LAKES AND OPEN WATER	BAYOUS/ CANALS	TOTAL
Straight-line flight	5.1	10.1	11.1	1.1	4.1	31.5
Perching	11.7	5.0	14.5	0.2	0.1	31.5
Soaring	0.4	3.0	0.7	2.9	4.1	11.1
Foraging	0.0	7.5	0.0	0.8	1.2	9.5
Foraging and soaring	0.0	0.8	0.0	0.8	0.7	2.3
Aggressive behavior	0.1	0.3	0.0	0.1	0.3	0.8
Courtship	0.0	0.2	0.0	0.2	0.0	0.4
Other	11.1	0.3	1.3	0.0	0.1	12.8
Total	28.4	27.2	27.6	6.1	10.6	99.9

dius. Eagle activity around the Paradis nest was concentrated at the nest. However, visibility of surrounding habitats from the observation location was limited. About 36% of the activity of the Paradis eagles occurred over swamp, which had a coverage of  $> \frac{1}{2}$  of the habitat within 4.8 km.

DISCUSSION

**Nest Site Characteristics.** We found that Bald Eagles in southern Louisiana nest predominantly in old, dominant baldcypress trees along a habitat interface adjacent to aquatic habitat. Almost  $\frac{1}{3}$  of the nest trees were either dead or had dead portions and, thus were highly susceptible to severe weather. Rebuilding of nests is common; however, nests lost during storms and hurricanes or other severe weather may limit productivity even after being repaired (Gerrard and Whitfield 1979; Swenson et al. 1986).

Our observations on reconstruction of nests in the original nest trees suggests that nesting eagles in southern Louisiana display a high degree of site tenacity. As nesting trees die and decay, suitable replacement trees must be available in the imme-

diate vicinity. Eagles often build a new nest within 1.6 km of a destroyed nest, usually within several hundred meters (Howell 1954). Data from our study indicate that most new nests are constructed within 100 m of the original nest site. The presence of perch trees in the vicinity of the nest is thought to be an important factor in nest-site selection (Sprunt et al. 1973; Shealy and Zwank 1981). Thus, preservation of mature baldcypress trees near eagle nests is essential in southern Louisiana.

**Observation of Nesting Pairs.** Nesting Bald Eagles in our study spent most of their time in straight-line flight over marsh or swamp, or perched at the nest. Our findings in part agree with those of Shealy and Zwank (1981), who found that adult Bald Eagles spend the majority of time perching (45.5%) and that activities such as foraging and soaring most often occurred over open marsh. Our finding that a small portion of time was spent foraging for food, previously noted by Shealy and Zwank (1981), may imply that foods are abundant and accessible near Bald Eagle nests or that eagles foraged away from nests and out of view.

Table 3. Total minutes and (percent) of observed time spent over various habitat types by three nesting pairs of Bald Eagles, 1977–78 and 1978–79.

HABITAT TYPE	NEST DESIGNATION		
	SOUTH BAYOU CHENE	PARADIS	WHITE KITCHEN
Marsh	4568 (42.9)	280 (4.0)	265 (5.7)
Swamp	2 (0.1)	2500 (35.9)	3085 (66.8)
Nest site	2876 (27.0)	4121 (59.1)	1269 (27.5)
Bayou and canal	1889 (17.7)	0 (0.0)	0 (0.0)
Lakes and open water	1314 (12.3)	70 (1.0)	0 (0.0)



ACKNOWLEDGMENTS

This paper is a contribution of the Louisiana Cooperative Fish and Wildlife Research Unit; U.S. Fish and Wildlife Service, Louisiana State University, Louisiana Department of Wildlife and Fisheries, and Wildlife Management Institute, cooperating. Financial support was provided by the Corps of Engineers, U.S. Army Engineer District, New Orleans, Louisiana. Appreciation is extended to the U.S. Fish and Wildlife Service, Jackson, Mississippi, for information and assistance.

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Address of first and second authors: Louisiana Cooperative Fish and Wildlife Research Unit, Louisiana State University, Baton Rouge, LA 70803. Address of third author: School of Forestry, Wildlife, and Fisheries, Louisiana State University, Baton Rouge, LA 70803.

Received 24 April 1986; Accepted 21 October 1986

**National Wildlife Rehabilitators Association Awards and Grants.** The National Wildlife Rehabilitators Association announces a small-grants program and the establishment of two awards. The grant makes funding available to support a single \$1000 project or several smaller projects that total \$1000 in the field of wildlife rehabilitation. Applicants must demonstrate financial need and submit a typewritten proposal that includes name(s) and résumé of personnel involved, objectives of the project, a brief description of how the project will be carried out, a brief statement of the literature reviewed and an itemized budget. An annual report on progress is required.

The awards include the Lifetime Achievement Award given to an individual whose primary identification is with rehabilitation of wildlife and who has contributed to this field in a major way for many years. The Significant Achievement Award is for a person who has contributed something of merit to the field in the last two yr. The contribution may be a research finding, publication, organization of a program, etc., with a major theme in wildlife rehabilitation. Both awards consist of a plaque, \$100, and free registration at the NWRA conference where the award will be presented. The deadline for submittal of proposals for the grant or nominations for the awards is 1 December of each year. They should be sent to: **Daniel R. Ludwig, Ph.D., Awards and Grants Committee, Willowbrook Wildlife Haven, Willowbrook Forest Preserve, P.O. Box 2339, Glen Ellyn, IL 60138. Telephone (312) 790-4900, Ext. 283.**

PIRACY, INSECTIVORY AND CANNIBALISM OF PRAIRIE FALCONS  
(*Falco mexicanus*) NESTING IN SOUTHWESTERN IDAHO

ANTHONIE M. A. HOLTHUIJZEN, PETER A. DULEY, JOAN C. HAGER,  
SCOTT A. SMITH AND KRISTIN N. WOOD

During a project to evaluate the effects of human activities on nesting Prairie Falcons (*Falco mexicanus*), we observed 24 pairs during the 1984 and 1985 nesting seasons over approximately 4400 hr (Holthuijzen 1984, 1985). Observations started at egg-laying or incubation and continued through brood-rearing until nestlings were 35 d old. We noted several falcon feeding behaviors which have not been previously reported or have received little attention in the literature. All observations were made within the Snake River Birds of Prey Area (BOPA) in southwestern Idaho. A more detailed description of the BOPA sagebrush steppe habitat can be found in U. S. Department of the Interior (1979) and West (1983).

Kleptoparasitism was recorded on 22 May 1985, when an adult male Northern Harrier (*Circus cyaneus*) with an unidentified prey item flew past a falcon eyrie and was attacked by the resident male, upon which the harrier dropped the prey item. The prey was recovered by the male falcon and fed to four 25-d-old nestlings. Skinner (1938) recorded acts of piracy by Prairie Falcons on Northern Harriers and suggested that this occurred on a regular basis. Other large falcons, such as the Peregrine Falcon (*F. peregrinus*), have also been reported to kleptoparasitize other birds (Brockmann and Barnard 1979).

We saw a female Prairie Falcon catch unidentified insects between 1707 and 1716 H (MST) on 22 May 1985. The insects were fed to four 10-d-old nestlings. Another female caught 16 insects between 1250 and 1352 H (MST) on 24 May 1985, and these were fed to two 22-d-old nestlings. The falcon immediately flew to the eyrie after each capture, fed the nestlings, and continued hunting. While circling in the air, the falcons turned their bodies and used their feet to capture insects, as described by Sherrod (1983) for recently fledged Peregrine Falcons hawking dragonflies (Order Odonata). The 10-d-old young Prairie Falcons had not been fed for 3.5 hr, and the two 22-d-old falcons not for eight hr prior to receiving insect prey. Young at both eyries received mammalian prey within 45 min after they were fed insects. Insects may have been used as an emergency food supply. Alternatively, a sudden abundance of insect prey may have induced opportunistic hunting behavior. Insect remains have occasionally been found in pellets of Prairie Falcons (Bond 1942; Ogden and Hornocker 1977; U.S. Department of the Interior 1979). Bond (1936) also observed Prairie Falcons catching insects.

Colonies of nesting Cliff Swallows (*Hirundo pyrrhonta*) occur in the BOPA. Cliff swallows and swifts (Family Apodidae) have been recorded as prey of Prairie Falcons

(Webster 1944; U.S. Department of the Interior 1979). We saw Cliff Swallows captured in the air by male Prairie Falcons diving repeatedly through flocks circling in front of cliffs; one male falcon caught two swallows during a day. We observed three captures on two separate days by two individual male falcons. On 14 June 1985 a male falcon flew to a swallow nest, clung to it upside down, and flew off 30 sec later clutching a Cliff Swallow that it had removed from the nest. The swallow was immediately delivered to an eyrie which contained 34-d-old nestlings. Nest robbing has not been previously recorded for Prairie Falcons, although such behavior has been noted for Peregrines (Cramp and Simmons 1980).

We observed cannibalism at one eyrie where a dead 26-d-old nestling partially blocked the eyrie entrance. The female pulled the nestling inside the eyrie, plucked it, and fed herself and the two surviving young. After several minutes, the female departed with the remains, landed on the ground near the base of the cliff, and continued plucking and feeding for another 14 min at three more locations before she disappeared with the remains. Cannibalism has not been previously recorded for Prairie Falcons. However, such behavior may not be unusual. We inspected two other eyries where nestlings were known to have died one and five days earlier, respectively, and found no signs of their remains. Scavengers may have removed dead young, but we consider this unlikely since adult birds remained in the vicinity and vigorously defended the eyries for at least seven days after the nestlings died.

ACKNOWLEDGMENTS

We thank A. R. Ansell, M. N. Kochert, K. Steenhof, R. D. Williams and L. S. Young for logistic support, assistance, and reviews of manuscript drafts. Comments by G. T. Allen, J. H. Enderson, D. E. Runde and S. K. Sherrod improved the manuscript. This paper is a joint contribution of the Idaho Power Company, the Bureau of Land Management, Snake River Birds of Prey Research Project, and the Pacific Gas and Electric Company.

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- Idaho Power Company, Environmental Affairs Dept., Box 70, Boise, ID 83707. Address of co-authors: Snake River Birds of Prey Research Project, Bureau of Land Management, 3948 Development Ave., Boise, ID 83705.**

Received 15 September 1986; Accepted 5 November 1986

*J. Raptor Res.* 21(1):33–35

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# ATYPICAL INCUBATION RATES AT A NEW MEXICO PEREGRINE FALCON EYRIE

ANTHONY P. CLEVINGER

Ratcliffe (1981) reported that in the Peregrine Falcon (*Falco peregrinus*) incubation during the daytime is mainly by females. Cramp and Simmons (1980) reported incubation is primarily by the female during the day and probably entirely at night. Of seven literature sources on Peregrine Falcon incubation (Dunaeva et al. 1948, cited in Cade 1960; Nelson 1970; Enderson et al. 1972; Harris and Clement 1975; Eberhardt and Skaggs 1977; Hunt 1979; Ratcliffe 1981), four indicate that males may incubate as much as one-half of the daytime period. This paper describes the atypical behavior of a pair in northern New Mexico in which the male's role greatly exceeded 50% of daytime incubation.

Nelson (1970) estimated males on Langara Island, British Columbia, at mid-incubation spent 30–50% of the daytime on eggs, but this decreased towards the end of the incubation period. Eberhardt and Skaggs (1977) discovered a male incubating 63% of the time in southern New Mexico. At another eyrie, on a day after a snowstorm, they observed a male incubate only 19% of the time in 11 hr. Hunt (1979) found a male's participation in northern California peaked at 60% about 5–10 d prior to hatching. Overall, the male incubated about 44% of the observed time. Ratcliffe (1981:219) reported that T. Cade found

that captive male Peregrines incubate, but their share varies greatly between individuals, reaching up to one-half of the daytime incubation. Time-lapse photography was used to accurately quantify incubation-sharing at five nests in late incubation on the Yukon River (Enderson et al. 1972). No male incubated 50% of daylight hours. At three nests 11–15 d before hatching, males averaged 39% (range 32–45%) of daylight incubation; at four nests, 6–10 d before hatching, males averaged 34% (range 31–37%); and at five nests, 0–5 d before hatching, males averaged 29% (range 15–41%), or an average of 34% incubation by males 15 d before hatching.

During the spring of 1982, I studied a pair of nesting Peregrines in northern New Mexico from late courtship until fledging of young. The eyrie was on a protected ledge of southeast aspect. Incubation began 6 April and lasted until 9 May when the first food deliveries suggested hatching. During this period, I watched 202 hr in 18 d. Observations were made continuously throughout the daylight period. On seven d (39%) observations were made from dawn to dusk. The mean times were between 0556 H and 1829 H (MST). The pair was observed with binoculars and spotting scope about 300 m from the eyrie. My presence did not appear to disturb them.



The male incubated an average of 63% (range 27–87%) of the daylight hours from 6 April to 9 May (Fig. 1) and averaged 154 min/incubation bout. The female incubated an average of 37% (range 12–72%) of the daylight hours and averaged 70 min/incubation bout. The female incubated a greater percentage of the day than the male on only two d, 30 April (55% vs. 44%) and 9 May (72% vs. 27%), the day of hatching. From mid-incubation onward, the male's role diminished, but the male continued to incubate longer than the female until shortly prior to egg hatching.

A typical incubation day was as follows; at first light ( $\pm 0500$  H) the male relieved the female for 2–4 hr. She returned to the eyrie and incubated while he hunted. Once prey was caught the male fed and immediately hunted again, consumed half of the prey and took the other half to the female, or took all of the prey to her. In the latter case he sometimes hunted for himself while the female ate and returned to the eggs, though generally whenever she was away from the eggs the male would incubate. If he was on the eggs when she finished eating, she perched for another 1–2 hr. Normally there were four or five nest exchanges/d. The male incubated for a greater part of the afternoon with the female relieving him near dusk. The female incubated overnight seven times between dark and first light. Only twice did it appear that the male may have incubated overnight, but I left the observation site shortly before dark and could not verify the next morning. Typically the female arrived at the eggs 15–30 min before dark and in two cases, the male was on the eggs within 15 min of darkness.

The eyrie was in sunlight from  $\pm 0600$ – $1230$  H when both sexes incubated equally. I found no correlation between either sex incubating and the presence of extremes in temp and precipitation. The male incubated as long as 5 hr 51 min in one period, and only twice did he leave the eggs before being relieved by the female. On 23 April, after 5 hr 20 min, and on 2 May, after 3 hr 16 min, the male left before the female relieved him. In the latter case, the female was perched nearby 36 min after the male began incubating. Two hr and 36 min later, she was still at the same nearby perch. Within two min the male left the eyrie and called; the female left her perch, called, and flew to the eyrie. On both exchanges eggs were unattended for only one min.

On occasion the week prior to hatching, the bird incubating would not leave the eggs in order to be relieved. A "confrontation" then occurred but normally lasted only 20–50 sec. One such confrontation/d was observed on 6, 7, and 8 May, and six occurred on 9 May, the hatching date. On 9 May, three occurred after the first egg was presumed to have hatched. Of 10 total confrontations observed at the eyrie the male "won" once, resulting in the female being turned away at the eyrie, and twice he relinquished incubation. This supports Cade's impression (1960) that birds incubate most intensely just before hatch-

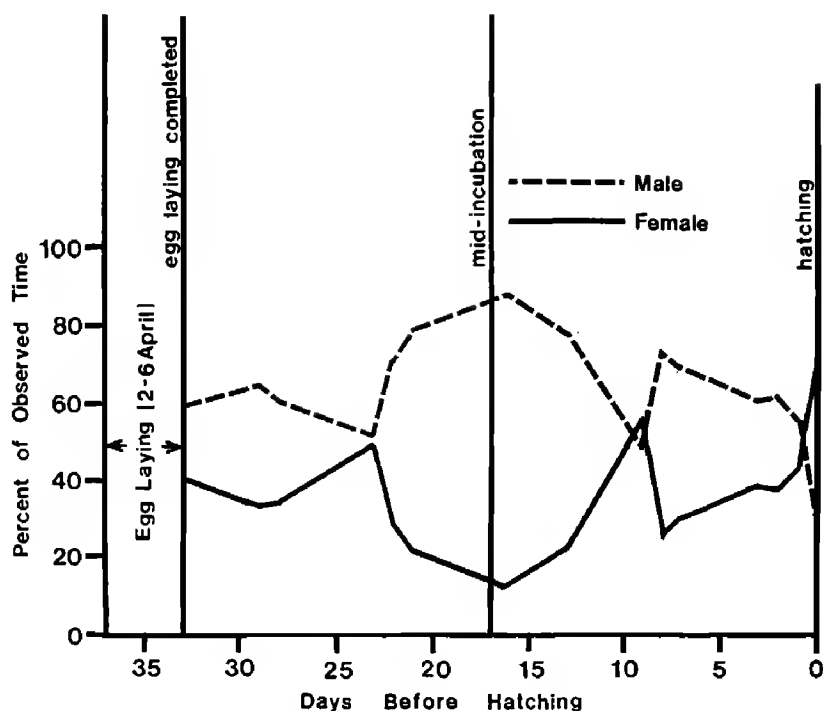


Figure 1. Percent of observed time engaged in incubation by an adult male and female Peregrine Falcon in New Mexico in relation to the number of days before hatching of eggs.

ing. Nelson (1970) and Wrege and Cade (1977) indicated that the female controls the relief schedule. If the male is sitting, he leaves almost immediately as the female arrives; if the female is sitting, she is less inclined to depart, and the male may have to beg for his turn by calling (Herbert and Herbert 1965). Although there is no mention in the literature of the female regulating the schedule by being away from the eyrie, this behavior could also be interpreted as a form of control by the female.

I infer that the female of this New Mexico pair may have had some control over the incubation schedules by her actions around the eyrie. She may have had a subnormal inclination to incubate or perhaps was a first-time breeder and thus inexperienced. In either case the result was abnormally long incubation bouts by the male, most of these occurring when the female was perched in the eyrie canyon and often visible to the incubating male.

During the male's 51 incubation bouts of a combined 6292 min, the female was either outside the eyrie canyon or outside my view during 1628 min (26%). The female was  $\leq 0.5$  km from the eyrie during 4664 min (74%). In contrast to the different incubation rates, brooding behavior was similar to other Peregrines. The female brooded 94% (range 82–100%) and the male 6% (range 0–17%) during seven days between four and 24 d post-hatch (four young fledged).

The role of the sexes in incubation from several regions is seen from a different perspective when compared to the New Mexico pair. A male northern Peregrine might incubate for a longer time than one in the south because of the longer daylength, or for the same number of hours regardless of photoperiod. In northern latitudes with cooler

ambient temp, females with a larger body size are better able to incubate a large clutch of eggs than a male (Cade 1960). If climate and latitude affect incubation duties, then rates at each latitude should reflect severity of the climate at the eyrie (i.e., females taking a larger share of duties in northern latitudes and less in the south). It is difficult to speculate from the limited data available how much latitude and climate influence incubation rates, though there appears to be much variation. When incubation rates of the northern New Mexico pair are compared to others, it is clear that the male incubated for a greater length of time/d and had a higher daytime incubation rate than reported elsewhere. Closer observations of incubating Peregrines are needed at different latitudes and climates in order to determine how the sexes are influenced by such factors as latitude, daylength, climate and individual behavioral variability.

#### ACKNOWLEDGMENTS

Sincere appreciation is extended to Kurt Nelson, Terry Johnson, and Richard Enriquez for their assistance and advice throughout the study. R. Wayne Nelson, James Enderson, and David Ellis provided important critical review of the manuscript. Funding was provided by the U.S. Forest Service.

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Received 20 August 1986; Accepted 3 December 1986

*J Raptor Res.* 21(1):35-38

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### NEST SITE CHARACTERISTICS OF PRAIRIE FALCONS IN THE MOJAVE DESERT, CALIFORNIA

DOUGLAS A. BOYCE JR.

Runde and Anderson (1986) summarized characteristics of Prairie Falcon (*Falco mexicanus*) nest sites in the western U.S. from written accounts (Decker 1931; Enderson 1964; Leedy 1972; Ogden 1973; Porter and White 1973; Platt 1974; Denton 1975; Ogden and Hornocker 1977; Williams 1981) and from their own work. Data from virtually all western states were included, except Arizona and California. This paper supplements Runde and Anderson's (1986) summary because: 1) the Mojave Desert is a major biotic province (Mojavian; Dice 1943)

containing a large breeding population of Prairie Falcons (Boyce et al. 1986) for which nest site characteristics have not been previously reported in detail, 2) some of my findings for the Mojave Desert differ from their data, and 3) I include data gathered at 44 nests studied by Millsap (1984) in westcentral Arizona.

I collected data on characteristics of Prairie Falcon nest sites in the Mojave Desert, California, from 1977 to 1979. In this report *nest site* refers to a specific location where falcons nest, usually a cliff but there are exceptions (cf.,

MacLaren et al. 1984). The *nest*, or *eyrie*, is the exact location at a nest site where eggs are laid. Nest variables measured included height (floor to ceiling, centered on the scrape), opening height and width (taken at nest entrance), length (entrance to back wall), floor area, entrance area, and aspect. Nests were categorized as either a pothole, crevice, ledge or stick nest. *Cliff height* was measured at the nest. *Eyrie height* was measured from the nest floor to the cliff base. *Cliff face area* was measured from photographs using a compensating polarimeter calibrated to known cliff height. Mean eyrie exposure and nonrandom orientations of circular data were inferred using Rayleigh's test (Zar 1984).

**Nest Sites.** Runde and Anderson (1986) noted that mean cliff height and eyrie height for western U.S. nest sites were highly correlated and that eyrie height averaged 63% of cliff height. The mean cliff height of 29.3 m (N = 52; SE = 7.1) for Mojave Desert nests was exactly the same as the mean for eight other western states, and the mean eyrie height of 18.3 m (N = 52; SE = 1.5) was only 0.2 m less than the western average. In westcentral Arizona mean cliff height and mean nest height were 19.8 m and 14.4 m, respectively, and nest height averaged 73% of cliff height (Millsap 1984). It is interesting to note that mean California and Arizona eyrie heights (as a percent of cliff height) were again in the same narrow range as other western nests. On this basis, nest site selection is inferred but data on availability of potential eyries at different heights has yet to be collected to test this hypothesis.

Mean cliff area for Mojave Desert nests was 1414 m<sup>2</sup> (N = 49; SE = 238) and was correlated with cliff height ( $r^2 = 0.78$ ). The correlation is not surprising since I calibrated cliff area using known cliff heights. This suggests, however, that cliff width must be relatively constant. If the correlation holds for other western U.S. localities, I would expect mean cliff area to be the same as that for the Mojave Desert since mean cliff heights, used in the calculation for both areas were the same. Millsap (1984) reported that in westcentral Arizona mean cliff area was considerably larger (7888 m<sup>2</sup>) than the Mojave Desert even though mean cliff height was lower, meaning falcons nested on low, wide cliffs.

**Nests.** Mean nest height (floor to ceiling) was much

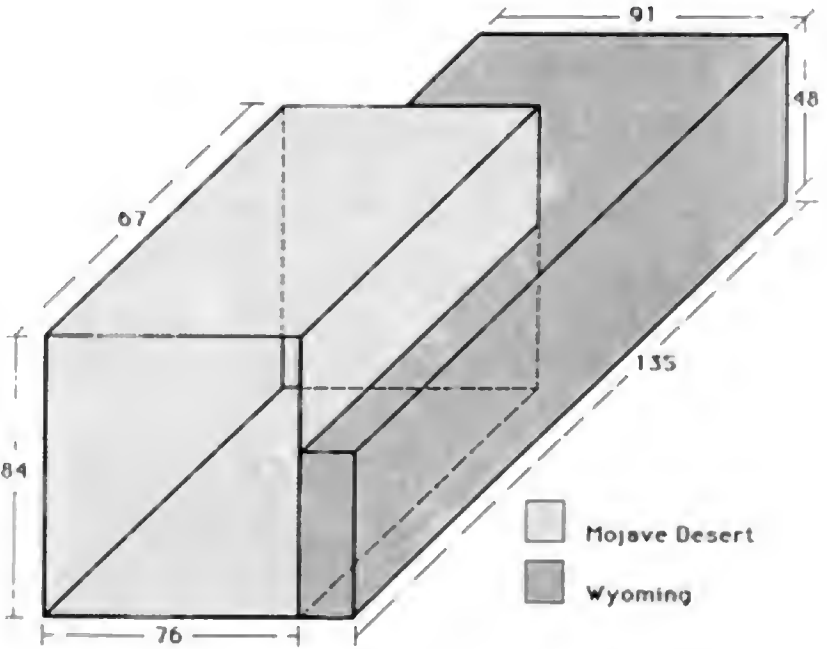


Figure 1. Comparison of the average three-dimensional shape of Mojave Desert Prairie Falcon nests with the mean shape for Wyoming nests. Dimensions are mean distances (cm) listed in Table 1.

higher than was reported from Wyoming (Table 1) but nest length and width were much shorter. Average floor area for Mojave Desert nests was 47% smaller, and the mean shape of nests differed considerably from the mean Wyoming shape (Fig. 1). This may be due to microenvironmental requirements. Williams (1984) recorded temps at one Prairie Falcon nest in Colorado during a 23 hr period on 10 June 1980. Nest temp fluctuated 7.4°C while ambient temp fluctuated 21.1°C during the day. Since the Mojave Desert is considered a hot North American desert (Jaeger 1957), the nest microenvironment may need to be different from the cooler Red Desert area of Wyoming in order for nest success to occur.

Stable nest temp may buffer nestlings from ambient temp extremes. Nest shape or volume may influence the temp range to which nestlings are subjected. The advantage of smaller floor area and smaller eyrie volume in the Mojave Desert is uncertain. It would seem that greater air volume would provide greater thermal enertia to changes

Table 1. Characteristics of Prairie Falcon nest sites in the Mojave Desert and southern Wyoming.

VARIABLE	MOJAVE DESERT				WYOMING <sup>a</sup>			
	$\bar{X}$	SE	RANGE	N	$\bar{X}$	SE	RANGE	N
Nest height (cm)	84.1	44.1	15–285	32	47.9	3.6	11–193	68
Nest width (cm)	76.2	6.1	34–244	50	91.2	7.5	18–313	70
Nest length (cm)	66.9	4.6	33–220	50	135.4	8.8	43–400+	71
Floor area (cm <sup>2</sup> )	7056	1936	645–23 658	53	9325	770	1600–29 275	70
Entrance (cm <sup>2</sup> )	6724	900	2235–190 602	39	5375	975	875–53 500	56

<sup>a</sup> From the "Red Desert" area (Runde and Anderson 1986).



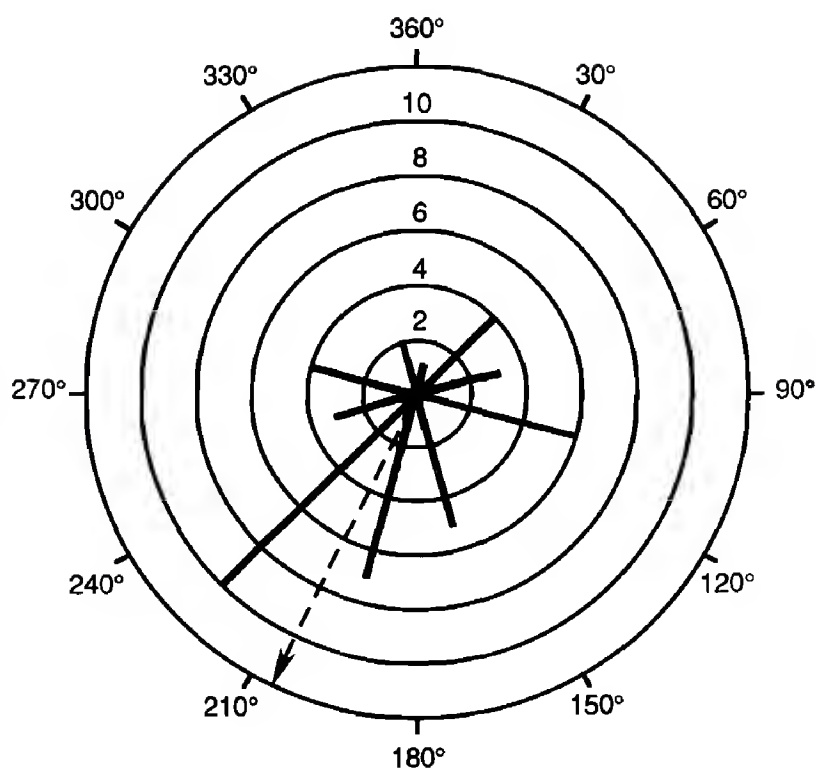


Figure 2. Frequency histograms of eyrie exposure for Prairie Falcons in the Mojave Desert 1977–79. The mean exposure is indicated by a broken line.

of ambient temp within the nest, which implies that nest selection is occurring. Again, data on availability of nest sites is needed to infer selection.

Prairie Falcons nest on ledges, in potholes, crevices and stick nests (Brown and Amadon 1968). Stick nests of the Common Raven (*Corvus corax*), the Red-tailed Hawk (*Buteo jamaicensis*) and the Golden Eagle (*Aquila chrysaetos*) were used by Prairie Falcons in the Mojave Desert. In other western U.S. localities, Prairie Falcons used potholes more (45%) than any alternative (crevice 15%, ledge 24%, stick nest 16%; Runde and Anderson 1986), but in the Mojave Desert Prairie Falcons used stick nests (49%) most often (crevice 0%, ledge 21%, pothole 30%). Stick nests were found on ledges (N = 20), in crevices (N = 4), and in potholes (N = 2). To eliminate stick nests as a category, I sorted stick nests into the three aforementioned categories (crevice, ledge, pothole) and then combined them with non-stick nests. On this basis, 31 nests (58%) were located on ledges, 18 (34%) were in potholes and four (8%) were in crevices.

There appear to be two reasons why stick nests are used frequently in the Mojave Desert. First, ravens are common in the desert and build nests on cliffs in locations that would otherwise be unsuitable for Prairie Falcons. They also build nests in locations that are suitable for Prairie Falcons. Second, potholes seem to be uncommon in the Mojave Desert. Potholes occur more commonly in sandstone cliffs. Granite, limestone and conglomerate cliffs dominate the landscape in the Mojave Desert, while sandstone cliffs occur infrequently.

**Aspect.** Twenty-one nests (40%) faced southwest, 15

(28%) faced southeast, 12 (13%) faced northwest, and five (9%) faced northeast (Fig. 2). The mean eyrie aspect averaged 207°, a definite southern exposure, and was only weakly significant ( $r = 0.21$ ;  $P < 0.10$ ). I do not know if the mean aspect of nests is due to a preponderance of south-facing cliffs. There was no relation between nest success and aspect (Boyce 1982). However, in westcentral Arizona Millsap (1984:30) noted “below 600 m elevation north facing cliffs were used more often and south facing less often than expected . . . . There was no detectable bias in cliff selection by aspect at higher elevation.” His opinion was that Prairie Falcons selected nests at low elevations to reduce heat stress.

Runde and Anderson (1986:26) inaccurately reported on Tyler’s (1923) observations for California: “In fact, Tyler (1923) reported that most Prairie Falcon eyries in southern California had northerly aspects and none were southerly. He attributed this to a scarcity of south-facing cliffs and an abundance of north-facing cliffs.” Tyler visited 17 nests over 22 seasons and confined his studies to a small area in central California, not southern California. Runde (pers. comm.) only mentioned Tyler’s work as it hinted at the availability of cliffs with southern aspects and suggested that a lack of south-facing cliffs could explain the lack of south-facing eyries.

**Management.** Descriptions of Prairie Falcon nest sites may be useful in formulating specific nest site management plans. The next two important steps are to 1) examine the relationship between physiographic characteristics of nest sites and productivity throughout the species’ range, and 2) adequately address the issue of use vs. availability in order to make more meaningful management recommendations. In the Mojave Desert, for example, Prairie Falcons fledged more young (<2) from nests located higher on the cliff ( $\bar{X} = 21.1$  m) than from nests located lower on the cliff ( $\bar{X} = 15.8$  m) and successful nests were higher in elevation ( $\bar{X} = 1084.5$  m) than unsuccessful nests ( $\bar{X} = 927.5$  m) (Boyce 1982). Once a relationship between nest site characteristics and reproduction is established, changes can be implemented at historical nest sites to improve reproduction or new nests can be created at previously unsuitable cliffs. Cliffs have been altered to improve existing natural features with subsequent nesting success (Boyce et al., 1980; Boyce et al. 1982).

Runde and Anderson (1986) suggested management guidelines for creating new nest sites, based on mean values derived from summarizing their data and data from eight other studies. There may be in fact an optimally shaped artificial nest that would be suitable throughout the entire breeding range. The fact that Mojave Desert nest shape differs substantially from Wyoming nests should alert managers to be especially aware of local patterns when implementing management programs. However, until it has been shown that regional differences in Prairie Falcon nest characteristics are due to selection, managers should be cautious in developing plans.

## ACKNOWLEDGMENTS

I thank B. Lehman, R. Hipp, and J. Boyce for companionship and assistance in the field. T. Kaiser, B. Millsap, J. Parrish, D. Runde and C. White provided critical review of the manuscript. The U.S. Bureau of Land Management, Dr. and Mrs. D. A. Boyce, and Mr. and Mrs. R. T. Whipple provided financial support for this study. I dedicate this article to D. Britt who loved wildlife, especially birds of prey.

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Department of Zoology, 574 WIDB, Brigham Young University, Provo, UT 84602.

Received 28 October 1986; Accepted 14 January 1987

*J. Raptor Res.* 21(1):38-39

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## ADULT PAIR OF MERLINS IN SOUTHERN UTAH IN JUNE

JAMES E. SAILER

While participating in a Utah Peregrine Falcon (*Falco peregrinus*) survey, the author and a co-observer sighted and confirmed the presence of an adult pair of Merlins (*Falco columbarius*) in southern Utah. The falcons were light in color and were thought to be *F. c. richardsonii*. Positive identification of the subspecies by a tail-band count was not possible.

Observations occurred on 1 June 1984, between 0955 and 1008 H (MDT), south of Bryce Canyon National Park (approx. 112°20'W longitude, 37°27'N latitude). Observations were made using a spotting scope (15 × 30). The female Merlin was sighted at 0955 H perched in a snag at the top of a 120 m, southeast-facing cliff, approximately 0.5 km from the observation site. At 0958 H she

made a shallow stoop to the northeast, parallel to the cliff face, and was lost from view behind a large outcropping on the cliff. Upon her disappearance, an adult male Merlin was sighted in the immediate area perched on a small rock spire of the outcropping. He remained until 1008 H and was subsequently lost from view. Neither falcon was seen again during the remaining two hr of observations. Further investigations were not possible due to the continuing Peregrine survey, and we were unable to document the Merlins' breeding status. The area of the sightings was approximately 2650 m above sea level, dropping 425 m in one km to the valley below. Flora above the cliff consisted chiefly of ponderosa pine (*Pinus ponderosa*), white fir (*Abies concolor*), and Douglas fir (*Pseudotsuga menziesii*). Habitat below the cliff varied from Pinyon pine (*Pinus edulis*) and Utah Juniper (*Juniperus osteosperma*) to grasslands as the elevation decreased (Elias 1980).

Two additional Merlin sightings were made in Canyonlands National Park on 17 and 18 June from two observation points approximately two km apart. Both Merlins sighted were adult males and were thought to be the same bird. Observations were made from the rim of the Colorado River Canyon on both occasions. Flora above the canyon was sparse; however, the canyon floor and many small side canyons in the area maintained populations of pine (*Pinus* sp.). The Merlin's breeding range extends from the taiga through the prairie-parkland biomes (Temple 1972). During the 19th century, it was found as a breeding bird in the Wasatch Mountains of northern Utah (Hayward et al. 1976), although no subsequent breeding records have been reported for this region (Oliphant 1985). Bailey and Niedrach (1965) considered this species a rare winter migrant of Utah, while Hayward et al. (1976) classified it as a sparse breeding resident. The nearest recent breeding by Merlins has been found in southern Idaho, southern Wyoming, northern Colorado and Nebraska (Lock and Craig 1975; Craig and Renn 1977; Lock 1979; Oliphant 1985; Becker pers. comm.).

Occurrence of this species outside of its documented breeding range during the summer months suggests it is not only a winter migrant within Utah as previously indicated. My observation dates fall within incubation and hatching periods of *F. c. richardsonii* in southeastern Montana (Becker and Sieg 1985) and correspond temporally with reports of Merlin breeding chronologies in south-

central Idaho (Craig and Renn 1977). Becker and Sieg (1985) reported that spring arrivals of Merlins at their study area in southeastern Montana occurred between 11 March and 23 April. Based upon this evidence, Merlins observed during my survey were not thought to be migrant birds returning north and may represent a breeding component in Utah.

#### ACKNOWLEDGMENTS

Ritt Enderson was co-observer and confirmed these sightings in the field. We thank the Peregrine Fund, Inc., and the National Park Service for enabling us to make these observations while participating in the 1984 Peregrine survey. Christopher Servheen, Dale Becker and Lynn Oliphant reviewed and commented on the manuscript.

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**P.O. Box 5832, Missoula, MT 59806. Present address:  
RD #1, Box 43A, Glen Gardner, NJ 08826.**

Received 1 June 1986; Accepted 16 December 1986



## COMMENTARY

### C.I.T.E.S. CLASSIFICATION OF THE GYRFALCON (Reprinted in part from *Wildlife Collectibles Newspaper*)

The status of the Gyrfalcon (*Falco rusticolous*) in Canada was a topic discussed at the Convention on International Trade in Endangered Species of Wild Flora and Fauna (C.I.T.E.S.) conference held 22 April–3 May 1985 in Argentina. Canada opposed foreign proposals which would interfere with the international trade of three species of wildlife. The one proposal accepted by the Convention, despite Canadian opposition, regarded the North American population of the Gyrfalcon. Until March 1981, all populations of Gyrfalcon were listed in Appendix I. Appendix I status is reserved for endangered species and prohibits export and import for commercial purposes. The North American population of the species was moved to Appendix II at the C.I.T.E.S. Conference in 1981. Old and New World Gyrfalcon populations have been treated differently under C.I.T.E.S.

Denmark and Norway proposed that the North American population be moved from Appendix II classification to Appendix I at the Argentina Convention (effective 1 August 1985). Under Appendix II classification, international trade was permitted with the Gyrfalcon by the Canadian government in some provinces. Denmark and Norway noted dramatic declines in Gyrfalcon populations in Iceland, Greenland, Norway, Sweden and Finland in their proposal to the Convention. The proposal went on to state that "Very little information exists regarding the Canadian population . . . status in Canada is so poorly understood that it remains unclassified by The Committee on the Status of Endangered Wildlife in Canada. Although

it has recently been under consideration for inclusion on Canada's endangered species list . . . , harvests have proceeded in two Canadian territories in recent years." On the other hand, Canadian Wildlife Service officials have stated that the Gyrfalcon's numbers in Canada are far greater than those in other countries.

Also cited in the proposal was the increase in illegal trade of Canadian Gyrfalcons. "Illegal trade . . . is apparently escalating to meet an increasing demand for the species, principally by falconers. White gyrs are the most highly prized colour phase, and the Canadian population contains some of the whitest gyrs in the world." As pointed out by Canadian Wildlife Service officials, black market trade in any species is not documented through government channels, and placing the Gyrfalcon in Appendix I will not measurably affect illegal trade but will affect those involved in legal trade.

Canada intends to make a proposal to move the North American population of the Gyrfalcon back to Appendix II at the next C.I.T.E.S. Convention to be held in Ottawa, Ontario, 12–24 July 1987. Classification of a species in a C.I.T.E.S. appendix is normally based upon the biological status of the species in question. The reclassification of the Gyrfalcon was not based upon a biological status of the species *per se*, but rather upon law enforcement difficulties involved with legal trade. The apparent precedent which the Parties have now set is cause for considerable concern.—**Jimmie R. Parrish and Clayton M. White.**

## INSTRUCTIONS FOR CONTRIBUTORS

### *The Journal of Raptor Research*

EFFECTIVE WITH VOLUME 21, 1987

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## DISSERTATION ABSTRACTS

### POPULATION DYNAMICS, HABITAT USE AND MOVEMENT PATTERNS OF THE PRAIRIE FALCON (*Falco mexicanus*)

A study of the effects of nestling removal from a population of Prairie Falcons (*Falco mexicanus*) in southwestern Wyoming was begun in 1982. The objectives were to determine if a harvestable surplus of young is produced and to document effects of reduced reproductive success on a breeding population. Reproductive success was experimentally reduced to <2.0 young/pair/yr—the number calculated to be necessary to maintain the population through time. To date, there is no evidence that nestling removal caused a decline in numbers of breeding pairs.

Data from Prairie Falcon nests in eight states demonstrated a consistent pattern of nest placement relative to height and aspect of nest cliffs. Nest height averaged 63% of cliff height. Aspects of eyries and nest cliffs tended to be southerly with no significant difference between eyrie and cliff exposures. Potholes in cliffs were the most frequently used nest sites. Patterns of occupancy and nest success in Wyoming were statistically independent of the physical habitat variables measured.

Estimates of survival were calculated using recent band recovery data. Maximum likelihood estimates of annual survival were 15% for juveniles and 72% for adults. Population modeling indicated that a reasonable range for annual adult survival was 70–85% with juvenile survival rates of 15–35%.

Annual turnover and survival of breeding adults were calculated from studies in Canada, Colorado and Wyoming. Annual turnover was estimated at 22%; adult survival was at least 81%. Survival of males was greater than that of females but the difference was not statistically significant. Complete turnover in a breeding population was estimated to require from five to eight yr.

Fidelity of individual falcons to previous breeding territory was 88%; median breeding dispersal distance was 3.2 km. Median natal dispersal was 12.9 km for 33 ♂♂; significantly less than the median of 54.4 km recorded for 55 ♀♀.

Median and modal age at first capture on territory was two yr. First-year Prairie Falcons occupied territories and nested successfully. Median age of falcons occupying nesting territories was three yr, the oldest breeder encountered was eight. **Runde, Douglas E. 1987. Ph.D. Department of Zoology and Physiology, University of Wyoming, Laramie, WY 82071, USA.**

### REVIEWERS FOR *Raptor Research*, 1986

Again this past year, numerous individuals have generously given of their time and expertise by serving as reviewers for manuscripts submitted for publication in *Raptor Research*. The Editorial Office greatly values the objective evaluations of reviewers in deciding upon the publishability of manuscripts. Each of the individuals listed below has served as a reviewer during 1986. The Editorial Staff expresses sincere appreciation to this battery for a job well done. Those individuals who have contributed reviews of two or more manuscripts are indicated by an asterisk.

Daniel A. Airola, Dale Becker, James Bednarz, David M. Bird\*, Peter Bloom\*, Gary Bortolotti, Reed Bowman, Douglas A. Boyce, Jr.\*, Tom J. Cade\*, Erick G. Campbell, Charles T. Collins, Erica Craig, Tim Craig, Walter Crawford, James Devereaux, David Ellis, James Ender-son\*, David L. Evans\*, David L. Fischer, Murray Fowler,

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## THESIS ABSTRACTS

### SONOGRAPHIC IDENTIFICATION OF INDIVIDUAL BREEDING BALD EAGLES (*Haliaeetus leucocephalus*) IN ARIZONA

“Chatter” calls of adult Bald Eagles (*Haliaeetus leucocephalus*) were recorded from 1983–86 at nesting territories along the Salt, Verde, and Big Sandy rivers in central Arizona. Sonagrams prepared from these field recordings were visually and quantitatively analyzed to test the feasibility of identifying individual eagles by voice. Visual identification tests were conducted with untrained volunteers to determine if individual eagles could be readily distinguished by their sonagrams. A stepwise discriminant function analysis (DFA) was performed on data produced from digitizing the sonagrams with a graphics calculator to identify those features of the eagle’s call that best distinguish individuals. Fifty-nine to 83% of the eagles were correctly identified in the visual identification tests. Eighty-three to 100% of the eagles were correctly identified in the DFA within a given year. The calls of an individual eagle, however, vary significantly both within and between years. This variation may limit the utility of sonagrams for purposes of individual identification. **Eakle, Wade Laney. 1986. M.Sc. Thesis, School of Renewable Natural Resources, The University of Arizona, Tucson, AZ 85721, USA. Thesis directed by R. William Mannan.**

### HABITAT SELECTION, MOVEMENTS AND ACTIVITY OF BOREAL AND SAW-WHET OWLS

Habitat selection, movement patterns and breeding season calling activity of Boreal (*Aegolius funereus richardsonii*) and Northern Saw-whet Owls (*A. a. acadicus*) were monitored from April 1980–June 1985 in Larimer and Jackson counties, northcentral Colorado. Intensive surveys were conducted in 1983 and 1984 to identify habitat requirements and to determine calling activity of the two species. Radiotelemetry was used in 1984 to determine the movement patterns and habitat selection of Boreal Owls.

Macrohabitat was analyzed for Boreal (N = 21) and Saw-whet Owl (N = 12) territories located in 1983 and 1984. Boreal Owls selected high elevation (2770–3300 m) mature spruce-fir (*Picea engelmannii*-*Abies lasiocarpa*) forests while Saw-whet Owls were found in lower elevation (2370–2700 m) deciduous or mixed forests. Saw-whet Owl territories (N = 6) had significantly more deciduous tree cover and smaller trees than did Boreal Owl territories (N = 18). Boreal Owls preyed primarily on Red-backed Voles (*Clethrionomys gapperi*) and *Microtus* spp., while Saw-whet Owls fed primarily on Deer Mice (*Peromyscus maniculatus*). Three Boreal Owls (two ♂♂, one ♀) were trapped and radio-marked in 1984. Home range sizes of the two ♂♂ increased significantly from the breeding season ( $\bar{X}$  = 296 ha) to post-breeding season ( $\bar{X}$  = 1132 ha). Analysis of roost site selection (N = 174) showed that Boreal Owls preferred roosts in dense tree stands on steep slopes. Extensive diurnal activity of the owls was observed.

Calling activity of both Boreal and Saw-whet Owls fluctuated considerably over a six-yr period (1980–85), probably due to changes in the prey populations. Overall length of the courtship period ranged from 31–119 d ( $\bar{X}$  = 63) for Boreal Owls and from 70–93 d ( $\bar{X}$  = 81.5) for Saw-whet Owls. Calling activity of Boreal Owls was slightly influenced by wind, precipitation and moon phase while cloud cover and temp had no apparent effect. Saw-whet Owl calling activity was influenced primarily by wind. **Palmer, David Andrew. 1986. M.Sc. Thesis, Department of Fishery and Wildlife Biology, Colorado State University, Fort Collins, CO 80523, USA.**

### RANGE, ACTIVITY, AND HABITAT USE BY NESTING FLAMMULATED OWLS IN A COLORADO PONDEROSA PINE FOREST

A radio-telemetry study of movements, activities, and habitat use by nesting Flammulated Owls (*Otus flammeolus*) was conducted in a 274-ha area of montane forest in central Colorado from April–October 1982–1983. Home range sizes for seven nesting pairs ranged 8.5–24.0 ha ( $\bar{X}$  = 14.0 ha, SD = 5.0). Range size appeared to be determined by



extent of patchiness on overstory tree species and age, while range shape appeared to be determined by topography, and juxtaposition of ranges of neighboring conspecifics. Foraging, done mostly by males, was most intense in the early evening but continued periodically throughout the night. Eighty percent of observed foraging attempts by males occurred in one to four intensive foraging areas (IFAs) within each home range. Mean size of 15 IFAs in seven ranges was 0.5 ha (range 0.1–1.4 ha, SD = 0.4), and mean total area in IFAs per range was 1.0 ha (range 0.6–1.5 ha, SD = 0.3). Distances from centers of IFAs to respective nests ranged from 10–410 m but most (73%) were <140 m from nests, and six of seven nests were contained within an IFA. Foraging areas, day roosts, and territorial song posts of males were mostly associated with mature, open stands of ponderosa pine (*Pinus ponderosa*) mixed with Douglas-fir (*Pseudotsuga menziesii*). One brood of three young and one brood of two young dispersed from the nest in different directions, with part of the brood being attended by the male and part by the female. Fledged young were dependent on adults for food for 13–17 d, but by 24–31 d young were no longer provisioned with food. Adults rarely associated with young after this time. Fledglings left the study area by 1 September and adults by 13 October. **Linkhart, Brian D. 1984. M.Sc. Thesis, Department of Fishery and Wildlife Biology, Colorado State University, Fort Collins, CO 80523, USA.**

*J. Raptor Res.* 21(1):46

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#### RESOURCE PARTITIONING IN AN ASSEMBLAGE OF BREEDING RAPTORS FROM SOUTHEASTERN WYOMING

Food habits and nest site features of Golden Eagles (*Aquila chrysaetos*), Prairie Falcons (*Falco mexicanus*), Red-tailed Hawks (*Buteo jamaicensis*), and Ferruginous Hawks (*B. regalis*) were studied near Medicine Bow, Wyoming, during 1981 and 1982. Foods consisted primarily of leporids and sciurids. Wyoming Ground Squirrels dominated the diet of Prairie Falcons, while Golden Eagles preyed on leporids more than the other raptors. Diet overlap ranged 59–99% between the species. Nest aspects varied widely but the mean used by this raptor assemblage was 300°. Mean height of nests and nest substrates used by Golden Eagles were greater than those of other species. Seventy-eight percent of the raptors nested out of sight of the nearest active neighbor, and 77% nested within view of a road. Overlap in use of different nest substrates ranged 62–94%. Prairie Falcons were the most specialized and Ferruginous Hawks the most versatile raptor species in terms of food habits and use of nest sites. In spite of high levels of overlap, detailed analyses suggested possible partitioning of leporid and sciurid prey and differential use of trees and cliffs as nest sites. **MacLaren, Patricia A. 1986. M.Sc. Thesis, Department of Zoology and Physiology, University of Wyoming, Laramie, WY 82071, USA.**

*J. Raptor Res.* 21(1):46–48

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#### NEWS AND REVIEWS

**Proceedings of the Second Symposium on African Predatory Birds** by J. M. Mendelsohn and C. W. Sapsford (Eds.). 1984. 245 pp. Published by the Natal Bird Club, % Durban Natural History Museum, P.O. Box 4085, Durban 4000, SOUTH AFRICA.

These proceedings represent the culmination of a symposium held at majestic Golden Gate Highlands National Park in South Africa, 22–26 August 1983. The proceedings contain a total of 43 contributions and four resolutions adopted at the symposium. Eighteen contributions are abstracts or extended abstracts, and three of the remaining 25 papers are in the form of notes. Eleven full length articles discuss natural history of species in specific regions of southern Africa. Two articles were on captive propagation, two on pesticides (others mention pesticide usage in southern Africa), four on general physiology and one article introduced falconry as an arm of conservation. Among the papers was an update on the distribution, status and conservation of raptors in Madagascar. The author list contains 64 names representing seven countries outside South Africa.

The status of raptors in Madagascar, as reported by Langrand and Meyburg, was alarming. Their report stated that most of the endemic raptors on the island are today rare, extremely localized, or both, as a result of extensive deforestation. The Madagascar Serpent Eagle (*Eutriorchis astur*) and the Madagascar Sea Eagle (*Haliaeetus vociferoides*) are now among the most threatened raptors in the world, and the Madagascar Serpent Eagle may already be extinct. The last reported sighting was in the early 1970s. Many of the remaining species are confined to small forested regions or are found locally. The Madagascar Kestrel (*Falco newtoni newtoni*) is the most abundant raptor on the island, and only two migrant species, the Eleonora's Falcon (*F. eleonorae*) and Sooty Falcon (*F. concolor*), occur on the island from mid-October to early May.

Ian Newton's paper on mortality and population turnover rate suggested several alternative methods for estimating these parameters from ring recoveries, as such tend to excessively overestimate life history parameters. His opinion was that more sound estimates can be obtained from local populations and their fidelity to breeding territory, and on this basis some species appear highly transient. Most of the data presented were from his work on the Sparrowhawk (*Accipiter nisus*), but the overall indication is that temperate-zone raptors have higher breeding and death rates than their tropical and sub-tropical equivalents.

The proceedings also contained a comprehensive overview of effects of organochlorine pesticides on birds by Dr. Newton. His conclusions indicated that aldrin and dieldrin were more toxic than DDT and DDE, causing mortality both of embryos and adults. The increased mortality resulting from these compounds led to very rapid population declines of Sparrowhawks and the Peregrine Falcon (*F. peregrinus*) in Britain. However, when organochlorine use has been stopped, remaining populations had a substantial increase in numbers.

A related paper by W. R. Thomson on DDT and other organochlorines in Zimbabwe causes even more concern. Estimates of tonnage application in Zimbabwe for 1982 amounted to 96% of the average annual application rate in the United States from 1956 to 1970. Content of DDT in human milk in Harare has ranged as high as 0.807 mg/l, which exceeds the previous world record high by 0.238 mg/l. Thomson reported that the political climate was more attracted to the low cost and effectiveness of DDT than to alternative methods. The escalated use of organochlorines in Zimbabwe is a matter of grave concern, and recent increases in birth defects have caused government administration and agricultural scientists to begin considering alternative methods of pest control. Indications are that a change in political attitude towards application of harmful pesticides is now changing for the better (P. Mundy, pers. comm.).

Tom Cade presented a paper which approaches the subject of captive propagation from a cost-benefit perspective. Alternatives to captive propagation are too often overlooked in today's notion that captive propagation is proper justification "to save species from extinction." Dr. Cade reports that this was not always so, however, and from time to time activities to preserve biological diversity in the world should be reconsidered. Sound advice, to be sure. Mostly within the last 20 yr has a strong interest developed in propagation for the purpose of saving species from extinction and restoring them in nature. The earliest successful efforts to do so was seen with the American Bison (*Bison bison*). Since 1970, considerable success has been achieved with captive propagation of raptors, and true domestication appears to be within reach for some members of *Falco*.

Nevertheless, Cade reported that captive propagation and reintroduction is labor-intensive and costly. For example, the California Condor (*Gymnogyps californianus*) program will have cost at least \$10 million by the time the captive-produced condors are ready to breed in the wild. Cade reported that to maintain 100 species of raptors in captivity at a minimum population level of 100 birds/species would cost approximately \$10 million/yr. On the other hand, these figures are lower than the purses awarded at some sporting events. Such poignant examples should cause anyone to reevaluate just how they spend their wealth. Obviously, funding is available for projects, but as Cade suggests, it is up to those of us who care most about these birds to convince others that they are worth the cost.

One of the final papers, by W. R. Thomson, reported on a system adopted by the Zimbabwe government, whereby falconry has been legalized and closely allied to raptor conservation. The paper outlined the strict system by which falconry is practiced in Zimbabwe, to include the requirement that all registered falconers complete record cards detailing the locations of breeding sites of all species of raptors used in the sport of falconry. As a result, official records of several species, including non-raptors, increased tremendously within a single year's time. Also, five of Zimbabwe's most experienced falconers were initially appointed as honorary officers of the Department of National Parks and Wildlife Management. Today, honorary falconry officers and all registered permit holders perform as arms of government. The result has been that the falconry community in Zimbabwe is able to police its ranks not simply as private citizens but as government officials. The system has further resulted in a beneficial and comfortable relationship between falconers and government and provides an example for serious consideration by other countries.

Resolution 1 passed at the symposium called for the intervention of international conservation and health agencies in affecting the discontinuance of DDT use in Zimbabwe, Zambia and other Third World countries and for manufacturing countries to discontinue the production and supply of DDT to Third World countries.

Resolution 2 encouraged zoological gardens and wildlife display organization in southern Africa to construct display/breeding cages for the Bateleur (*Terathopius ecaudatus*) and to display educational materials on the role of raptors in the ecosystem as well as causes and consequences of their extirpation.

Resolution 3 commended the South Africa Agricultural Union's stand to prevent poisoning of birds of prey and vultures on South African farms.

Resolution 4 recommends the marking of FM and other communications towers in parts of South Africa in order to reduce mortality to vultures.

Only three of the 43 papers discussed some of Africa's owls. In light of apparent declines with many diurnal species as reported, it would seem that a natural follow to the symposium would be to bring together a similar data bank on Africa's nocturnal raptors. Yet, all in all, the proceedings are highly recommended reading for any ornithologist or raptor biologist, particularly those who are currently conducting studies in that region of the globe.—**Jimmie R. Parrish.**



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